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ABSTRACT

The purpose of this meta-analysis of 77 advance organizer research reports was to identify characteristics of the experimental settings and materials that had relationships with the treatment effects obtained through the use of advance organizers. The dependent variables used to represent the treatment effects were the t-statistic for the difference between means and the probability level of significance. The independent variables described characteristics of the sample, treatment administration conditions, type of subject matter, quality of the research procedures, and characteristics of the AO and learning materials. The distribution of the computed t-statistics indicated a tendency for AOs to show facilitative effects. The following conclusions were based on the correlations between independent and dependent variables. Some of the reported facilitative effects of AOs may have been due to the possible contribution of the AO alone to answering the test questions or to an inequality of study time for the treatment groups. Student inability to understand the AO information may account for some of the non-significant findings. Comparative AOs may be more effective than expository ones. AOs may be more effective for classificational concepts and for students at higher grade levels. A list of guidelines for future AO research is included. (JK)

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A META-ANALYSIS OF SELECTED ADVANCE ORGANIZER RESEARCH REPORTS FROM 1960-1977

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

By

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* * * * *

The Ohio State University
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ABSTRACT

A META-ANALYSIS OF SELECTED ADVANCE ORGANIZER RESEARCH REPORTS FROM 1960-1977

By

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The Ohio State University, 1978
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This study is a meta-analysis of selected advance organizer research reports. The study was undertaken because there is a large amount of research in this area, but literature reviews that have attempted to integrate this research have generally failed to reach any definitive conclusions. The purpose of the analysis was to determine whether or not there were any characteristics of the experimental settings or materials that had consistent relationships with the treatment effects obtained through the use of advance organizers.

The procedures involved the identification of advance organizer research reports, the collection of the experimental materials, and the detailed analysis of these reports and materials. The units of analysis were research reports of experiments for determining the facilitative effects of

specific prose advance organizers for specific sets of learning materials involving comparisons of achievement for groups that received advance organizers with achievement for groups that did not receive advance organizers. The sample consisted of 99 such experiments reported in 77 research reports. A total of 91 different advance organizers was identified and copies were obtained for 71.

A number of variables were defined and quantified to enable the coding of data from the reports and materials. The two dependent variables were measures of the magnitude of the difference between the achievement means for the advance organizer and control groups. The independent variables described characteristics of the sample, treatment administration conditions, type of subject matter, quality of the research procedures, and characteristics of the advance organizers and learning materials.

The data analysis involved the computation of descriptive statistics, the examination of the relationships between independent and dependent variables by correlation coefficients and stepwise multiple regression analysis, and the examination of the inter-relationships among the independent variables by factor analysis.

Of the 99 t-statistics computed for the experimental comparisons between advance organizer and control groups, 68 were positive indicating that the observed means for the advance organizer groups were higher than those for the control groups. Twenty-two of these positive t-statistics were statistically significant while none of the twenty-nine negative t-statistics were significant. There were two t-statistics that were zero.

Ten of the sixty-three independent variables had significant correlations with both dependent variables. Seven had significant correlations with one dependent variable but not the other. The following conclusions are based on these correlations.

Some of the significant findings in favor of advance organizers may have been due to the possible contribution of the advance organizer alone to answering the test questions or to an inequality of study time for the treatment groups.

Student inability to understand the advance organizer information may account for some of the non-significant results. Advance organizers are probably more likely to show facilitative effects when the reading level is appropriate to the grade level, when the rate of introduction of new ideas is slower, when the content is less complex, and when students are given more time to process the advance organizer information.

There was an indication that comparative advance organizers may be more effective than expository ones.

The dependent variables had significant correlations with subject area, concept type, and grade level indicating that advance organizers may be less effective when the subject matter is science, more effective for classificational concepts, and more effective at the higher grade levels. The relationship of subject area with the dependent variables was probably largely due to its relationship with grade level and concept type.

A number of recommendations for future advance organizer research were made on the basis of the relationships identified in this study.

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CHAPTER I

INTRODUCTION

Need for the Study

Since the early sixties, a large number of research studies have been done to examine the effect of advance organizers, as defined by Ausubel (1960), on meaningful reception learning. An advance organizer is a set of introductory learning materials designed to establish a general idea within the learner's cognitive structure. This general idea is to serve as an anchor to which the specifics of the new learning material can be linked, thus facilitating the incorporation of the new material into the learner's existing cognitive structure.

Based on a review of thirty-two research studies on advance organizers, Barnes and Clawson (1975, p. 651) concluded that the results of existing research in this area are inconclusive and inconsistent. Some studies have shown that subjects receiving advance organizers scored higher on achievement tests than did subjects who received other introductory passages such as historical overviews or who were not given any introductory materials. Other studies showed no significant differences between experimental and control groups. In an attempt to identify variables which might help to explain these apparent inconsistencies, Barnes and Clawson classified the studies according to length of treatment, learning ability of subjects, grade level, mode of presentation of the advance organizer, subject area, and cognitive level of the test questions. However, they did not form any generalizations (Barnes and Clawson, 1975, p. 651). The type of review done by Barnes and Clawson has two main limitations. One limitation is that they did not perform any statistical analysis of their data. Because of the large number of variables involved, simple frequency counts probably will not provide a sufficient basis for the formation of valid generalizations. Some statistical analysis, including multivariate procedures, should be used to reveal relationships and to help identify variables that may provide insight in developing explanations of the reported results.

A second limitation of their review is that they did not consider the content and organizational properties of the materials used as advance organizers. Since there is not complete agreement as to the specific definition of the term advance organizer, this may be a very important variable. Many researchers have indicated that they feel that Ausubel's definition of advance organizer is too vague to provide specific guidelines for the construction of materials to serve as advance organizers (Allen, 1970a, p. 62; Lucas, 1972, p. 65; Saretsky, 1975, p. 92; Toth, 1975, p. 3). Consequently, there is considerable variety in the type of materials used in the advance organizer research. They vary in length from a single sentence (Christie and Schumacher, 1975) to a full week of instruction (Zuck, 1974). They vary in content from a brief statement of the topic (Christie and Schumacher, 1975) to a detailed definition of a complex concept (Kuhn, 1967). While the most common format used to present the information is written text, other formats such as game simulation (Livingston, 1970) and visual displays (Weisberg, 1970a; 1970b) have been used. Because of this variation, any attempt to interpret the results of the research on advance organizers without an examination of the experimental materials could be misleading.

Hartley and Davies (1976, p. 275) feel that further experimental research in this area should be delayed until some agreement can be reached concerning an operational definition to guide the construction of advance organizers. Glass (1976) has indicated that there is an increasing need for the type of research which uses previous studies in a particular area as the unit of analysis. He has introduced the term meta-analysis to refer to this type of research. He feels that the traditional literature review cannot provide an integration of research results when large numbers of studies are involved and many variables must be considered. The important variables in these studies must be quantified and statistical procedures must be applied in order to identify relationships and trends. "In educational research, we need more scholarly effort concentrated on the problem of finding the knowledge that lies untapped in completed research studies . . . This endeavor deserves higher priority now than adding a new experiment or survey to the pile." (Glass, 1976, p. 4). A detailed quantitative analysis of the experimental conditions and materials in the existing research on advance organizers should be very helpful for interpreting the results and for making an assessment of the impact of advance organizers on learning.

Purpose of the Study

One purpose of this study is to provide a detailed description of the characteristics of advance organizers that have been used in research and of the conditions under which the research was done. However, the main emphasis of the study is directed toward the analysis of existing research to identify characteristics or conditions which are significant predictors of the effects obtained through the use of advance organizers. Relationships identified in this analysis can serve as guidelines to help clarify the concept of advance organizer. The analysis also provides a basis for recommendations concerning the conditions that should be controlled and the variables that should be measured in future advance organizer research.

Statement of the Problem

The research problem in this study is to identify trends and relationships among the variables relating to the subjects, research procedures, content to be learned, experimental materials, and research results found in existing research studies on advance organizers, and to identify variables which may have potential explanatory value for the interpretation of the reported results of this research.

Definition of Terms

Subsumer: A subsumer is a general idea in cognitive structure to which more specific ideas and facts can be linked (Ausubel, 1962).

Advance Organizer: An advance organizer is a set of introductory instructional materials designed to establish a subsumer within the learner's cognitive structure (Ausubel, 1968).

Control Introduction: A control introduction is a set of introductory materials which was given to a control group in place of the advance organizer in an experiment to determine the effectiveness of an advance organizer.

Learning Materials: The term learning materials or learning activities will be used to refer to that portion of the learning experience in an advance organizer experiment that the experimental and control groups had in common.

Meta-Analysis: In meta-analysis, previous research studies serve as the unit of analysis. A number of variables related to these studies are quantified and examined by statistical methods. The purpose of meta-analysis is to provide an integration and interpretation of the results of a large number of studies in a particular area of research (Glass, 1976).

Dependent Variables: These are measures of the magnitude of the difference between the achievement means for the advance organizer and control groups.

Independent Variables: The independent variables describe the conditions under which the advance organizer research was done and the characteristics of the advance organizers and learning materials used in the research.

Concept: A concept is a verbal label which is assigned to "ordered information about the properties of one or more things--objects, events, or processes--that enables any particular thing or class of things to be differentiated from, and also related to, other things or classes of things" (Klausmier and Bernard, 1973, p. 11).

The following four definitions are all related to the concept of kinetic structure developed by O. R. Anderson (1971). Kinetic structure analysis examines the serial ordering of information in a verbal communication and the relatedness of adjacent segments of the communication (O. R. Anderson, 1971, p. 7). The first two define terms used in the coding procedures for obtaining the data from the communication for the analysis. The last two define properties of the communication which are computed from the data.

Discourse Unit: A discourse unit represents a complete thought in a verbal communication. This can be a complete sentence or a part of a sentence containing the subject, predicate and modifying subordinate clauses (O. R. Anderson, 1971, p. 29).

Verbal Element: A verbal element is a word or phrase in a verbal communication which contributes to the substantive meaning of the communication (O. R. Anderson, 1971, p. 31).

Commonality: Commonality is a measure of the extent to which adjacent discourse units in a verbal communication contain common elements (O. R. Anderson, 1971, p. 13).

Progression Density: Progression density is a measure of the rate at which new elements are introduced in a verbal communication (O. R. Anderson, 1971, p. 17).

The next four terms relate to a procedure for analyzing instructional materials to identify the properties and sequencing of the information included for the purpose of teaching concepts.

Instructional Move: An instructional move is a segment of the instructional materials presenting a piece of information designed to clarify the meaning of a concept (Henderson, 1967, p. 573).

Characterization Move: A characterization move is an instructional move that describes an attribute of a concept (Henderson, 1967, p. 575).

Exemplification Move: An exemplification move is an instructional move that identifies a member or non-member of the set of elements subsumed by a concept (Henderson, 1967, p. 576).

Teaching Strategy: A teaching strategy is defined by a specific sequence of instructional moves (Henderson, 1967, p. 575).

Limitations

There are two main factors which have imposed limitations on the present study. One limiting factor concerns the availability of the experimental materials used in the advance organizer research. The materials obtained for analysis in the present study show a bias toward materials used in original research reported in dissertations. Since these can be obtained from University Microfilms, it was possible to obtain the materials for nearly all of the studies that were identified because most of the dissertations contained copies of the materials used. When educational journals and ERIC microfiche were the source of the original research, the materials were more difficult to obtain because they were rarely included in the reports.

The second limitation is that the analysis could not deal with variables for which data could not be obtained from the original reports or materials. The existing research on advance organizers has generally neglected to control for alternate explanations for the results. For example, nonsignificant results could be explained by the possibility that the subjects already had an appropriate subsumer prior to the experiment or by the possibility that the advance organizer failed to provide a relevant subsumer. The latter condition could have resulted from the failure of the subjects to understand the information in the advance organizer or from the use of inappropriate content in the advance organizer. Another confounding variable is the possible affective effects of the control introduction. If the control introduction were more interesting or boring than the advance organizer, the performance of the control group could have been affected by their increased or decreased state of arousal. Since the testing required to control for these factors has generally been omitted from the research designs, the present study was not able to address these questions. Attempts were made to create variables which would allow an indirect examination of motivational factors and of the adequacy of the intended subsumers, but they were abandoned because of the failure to generate workable operational definitions.

Delimitations

The delimitations relate to decisions that were made concerning the selection of the studies to be included in the analysis and the identification of variables to be used in the collection of data from each study.

During the initial stages of the study, all research reports that were identified as being related to advance organizers by the author or in summary indices such as ERIC and the Education Index were examined. However, not all of these studies were retained for analysis. In order for a study to be included in the analysis, it had to meet the following criteria:

1. The alternate activity to be used with the control group in place of the advance organizer cannot be some other preinstructional strategy which is designed to facilitate learning.
2. The introductory passage used as an advance organizer must present a general idea that is intended to act as a subsumer for the learning activity to follow.
3. The primary mode of presentation of information in the advance organizer must be prose.

These criteria are discussed in more detail in Chapter III in the section on the sample. The discussion in Chapter III also describes some of the characteristics for some of the studies which were eliminated from the analysis because they failed to meet these criteria.

Time was a major factor which influenced the selection of the variables to be used in the analysis of the experimental materials used in the advance organizer research. Some variables which were considered in the initial stages of the analysis were dropped because of the length of time required to extract the information from the materials. The emphasis was placed on the analysis of the advance organizers rather than on the main learning materials. The learning materials were considerably longer than the advance organizers and the time required for a detailed analysis of these materials would have been prohibitive. Some of the variables were dropped from the analysis because there was not enough variation across studies to justify their inclusion.

Hypotheses

Since the purpose of the study is to identify variables which may help to interpret the results of the existing advance organizer research, the relationships of all of the independent variables with the dependent variables will be examined. However a number of relationships were predicted prior to the analysis. These predictions are identified in the form of eight hypotheses. The development of these hypotheses is discussed in Chapter III in the section on the rationale for the selection of the variables and stated hypotheses.

Hypothesis 1: Advance organizers will have a greater tendency to show facilitative effects as the grade level of the subjects increases.

Hypothesis 2: Advance organizers will have a greater tendency to show facilitative effects as the learning ability of the subjects increases.

Hypothesis 3: Advance organizers will have a greater tendency to show facilitative effects as the amount learned from the learning materials increases.

Hypothesis 4: Advance organizers that are written at a reading level appropriate to the grade level of the subjects will have a greater tendency to show facilitative effects.

Hypothesis 5: Advance organizers will have a greater tendency to show facilitative effects as the commonality coefficient increases.

Hypothesis 6: Advance organizers will have a greater tendency to show facilitative effects as the progression density coefficient decreases.

Hypothesis 7: Advance organizers will have a greater tendency to show facilitative effects if they contain a combination of exemplification and characterization moves rather than just one or the other.

Hypothesis 8: There will be a greater tendency for control groups to perform as well as advance organizer groups on the achievement tests when the main ideas in the advance organizers are repeated in the learning materials.

Plan of the Report

The report is presented in five chapters. Chapter I is an introduction which includes the need for the study, the purpose of the study, the statement of the problem, definition of terms, delimitations, limitations, and hypotheses. The literature review in Chapter II presents a discussion of the theoretical framework underlying advance organizers, definitions of the advance organizer concept, some general reviews of advance organizer research, and the literature which served as a basis for defining some of the variables used in the analysis for this study. In Chapter III, the research procedures are described, the sample is defined, the variables used in the analysis are identified and defined, and the procedures used in the data analysis are discussed. Chapter IV presents the results. Chapter V presents the summary, conclusions, and recommendations.

CHAPTER II

REVIEW OF THE LITERATURE

The five sections in this chapter fall into two categories. The first three sections discuss the literature related to advance organizers, and the other two discuss the literature that served as a basis for the definitions of some of the variables used in the analysis of the advance organizers. The theoretical literature related to the development of the advance organizer concept is presented in the first section. The second section deals with the definition of the advance organizer concept. The third section presents a discussion of some literature reviews of advance organizer research. The fourth and fifth sections deal with kinetic structure and teaching strategy variables respectively.

Theoretical Literature in Support of Advance Organizers

The use of advance organizers is an instructional strategy which is based on Ausubel's subsumption theory of meaningful reception learning. The main components of this theory are cognitive structure and the processes by which an individual's cognitive structure develops. Ausubel (1968, pp. 50-57) postulated a hierarchically organized cognitive structure. Within a given sphere of knowledge specific facts are subsumed under simple concepts. These concepts are subsumed under more complex, more inclusive concepts. Novak (1977, p. 75) used tree diagrams to represent these organizational properties. The trunk of the tree represents a broad concept and the branches and twigs represent the less inclusive concepts and facts which are interrelated through the broad concept. An individual's cognitive structure consists of a number of such hierarchies with varying degrees of complexity. The "trees" grow as new information is linked to existing structures and as two or more structures are joined through their relationships with a still more inclusive concept. A concept having a number of less inclusive concepts and facts linked to it is called a subsumer.

Once a subsumer is established in cognitive structure, it can provide anchorage for new learning materials, and it can help the learner to organize a large body of facts around a common theme. This process is an essential aspect of Ausubel's definition of meaningful learning (Ausubel, 1968, pp. 83-98). He claims that meaningful learning cannot take place unless the ideas and facts in the learning materials can be linked to and subsumed under some idea already in the learner's cognitive structure. If the learner does not have relevant subsumers to which the new materials can be related, he will be forced to memorize isolated facts. Therefore, one essential criterion for meaningful learning is the existence of relevant, clear, stable, and generalizable subsumers in the learner's cognitive structure.

When learners do not have appropriate subsumers for a particular set of learning materials, Ausubel (1968, pp. 148-149; 1970, pp. 1-6) has recommended the construction of special introductory materials (advance organizers) designed to generate a subsumer within the learner's cognitive structure. Advance organizers may also be used to identify potential subsumers which may already exist in the learner's cognitive structure and to show their relevance to the new learning materials.

The effectiveness of advance organizers as an instructional strategy is dependent upon the validity of the claim that relevant subsumers in cognitive structure can facilitate the incorporation of new information. Some research into this question has been done (Kahle, 1971; Ring and Novak, 1971; Talisayon, 1972). The procedure used in these studies involved the identification of concepts which could act as subsumers for the information in the new learning materials, the measurement of the subjects' understanding of these concepts prior to exposure to the materials, and the correlation of this prior understanding with achievement scores measuring learning from the new materials. In these studies, prior understanding of the concepts postulated as subsumers was shown to be a significant predictor of achievement. Ring and Novak (1971, p. 330) also demonstrated that prior knowledge of concepts was more critical than prior knowledge of facts. Prior knowledge of facts facilitated new learning only in the presence of the appropriate conceptual framework.

One weakness of these studies is that the researchers did not have any control over the conditions contributing to the differences in the entering characteristics of the cognitive structure variables of the subjects. It is possible that the subjects who had a better understanding of the subsuming concepts also possessed characteristics such as increased interest in the subject area or certain learning skills which may have contributed to their better understanding of the new material. Talisayon (1972) and Kahle (1971) included learning ability variables in their analyses to deal with this problem. They found that the cognitive structure variables were better predictors of achievement than were the learning ability variables.

Some attempt has been made to control for these variables in advance organizer research. The assumption is that advance organizers deliberately manipulate cognitive structure in an experimental setting prior to the learning activity. Improved performance is then concluded to be caused by the change in cognitive structure produced by exposure to the advance organizer.

Defining Advance Organizer

An advance organizer is a set of introductory instructional materials designed to establish a concept in cognitive structure which can serve as a subsumer for the detailed learning materials to follow. While Ausubel has not provided an operational definition for the construction of advance organizers, he has described a number of characteristics which they should have. An advance organizer should be written at a higher level of abstraction, generality, and inclusiveness than the learning materials, and the ideas presented in the advance organizer should be selected so as to maximize their potential for explaining and integrating the ideas and facts in the learning materials. Advance organizers must use terms which are familiar to the learner. The specific relevance of the ideas presented in the advance organizer to the content of the learning materials should be specified (Ausubel, 1968, p. 148; 1970, pp. 2-6).

Ausubel and Fitzgerald (1961, p. 266) have defined two types of advance organizers: expository and comparative. When the learning material is completely new to the learner, an expository organizer should be constructed in which a subsumer is generated through the use of vocabulary which the learner understands and through reference to concrete experience. If the new material represents a variant of some related concepts which have been previously learned, a comparative organizer should be used. A comparative advance organizer should identify similarities and differences between the new materials and the ideas which are already a part of the learner's cognitive structure. The specific relevance of the concepts in the advance organizer to the content of the learning passage should be identified.

Novak (1977, p. 79) stated that "advance organizers probably function only to the extent that some relevant subsumers exist, and association between existing subsumers and new information is perceived by the learner." He has introduced the term cognitive bridging to refer to the function of advance organizers. The cognitive bridge established by the advance organizer can serve to link previously learned concepts, thus creating a subsumer for the new information.

There is some disagreement in the literature concerning the exact nature and function of advance organizers. Lawton and Wanska (1977, pp. 1-4) felt that the basic function of advance organizers as stated by Ausubel has often been misinterpreted. They disagreed with Barnes and Clawson (1975, p. 637) who stated that the purpose of advance organizers is to relate new material to existing cognitive structure. Lawton and Wanska felt that advance organizers must modify existing cognitive structure rather than simply act as an intermediary catalyst between existing cognitive structure and new knowledge. The concepts presented in the advance organizer must become a part of cognitive structure to provide a subsumer to which the content of the learning material can be linked. Familiar ideas in cognitive structure and concrete experiences must be incorporated into the advance organizer so that the intended subsumer will have maximum clarity and stability.

Questions and behavioral objectives presented prior to learning materials have been called advance organizers in the research literature (Duchastel, 1973; Dwyer, 1971; Maher, 1975; Yawkey and Dashiell, 1973). However, it is probable that they serve a different function from that described by Ausubel for advance organizers. In a review of the literature on preinstructional strategies, Hartley and Davies (1976, pp. 241-245) indicate that the most widely accepted explanation for the facilitative effects of pre-test questions and behavioral objectives is that they focus the learner's attention on that portion of the learning material directly related to the questions and behavioral objectives.

There has been some tendency to confuse the terms subsumer and advance organizer. Many researchers have used the terms interchangeably (R. A. Graber, 1972, p. 28; Hawkins, 1972, p. 16; Jones, 1974, p. 2; Lucas, 1972, pp. 7-8; Thelen, 1970, p. 98; Toth, 1975, p. 5). All of these studies deal with advance organizers as introductory learning materials. Pella and Triezenberg (1969) used the term advance organizer to refer to the concept of equilibrium acting as a subsumer for a unit on ecological systems. This confusion has probably been fostered by some of Ausubel's early writing on this topic. He has made frequent reference to the organizing function of subsumers and stated that "subsumers thus become advance organizers or anchoring foci for the reception of new materials" (Ausubel, 1960, p. 270). In this quotation, the term advance organizer was probably used in description of the function of subsumers rather than as a synonym. However, his later discussion of the characteristics of advance organizers, particularly his discussion of the differences between advance organizers and introductory overviews, has clearly identified them as learning materials (Ausubel, 1970, pp. 2-4).

The distinction between subsumers and advance organizers is important both in designing research and in interpreting the results. The question, do advance organizers facilitate learning, must not be confused with the question, do relevant subsuming concepts in cognitive structure facilitate learning. The intermediate question, are advance organizers an effective means of generating subsumers, must also be investigated. This last question has been generally ignored in the advance organizer research. Only two studies were identified which specifically investigated the effects of exposure to advance organizers on cognitive structure variables (Baylis, 1975; Lawton, 1977). In both studies, changes were noted as a result of exposure to the advance organizer.

Literature Reviews of Advance Organizer Research

Most of the research reports on advance organizers made some reference to previous research as a part of the rationale or in the literature review. These reviews will not be discussed here. This section deals with those publications for which the main objective was a literature review.

Barnes and Clawson (1975) reviewed 32 studies. Their initial classification divided the studies into those that showed facilitative effects in favor of advance organizers (twelve) and those that did not (twenty). They also generated a number of two-way frequency tables for which one variable was the dichotomous division into studies having significant differences in favor of advance organizers and those having non-significant differences. The variables which were crosstabulated with this dichotomous variable were length of treatment, ability of students, subject area, grade level, presentation mode of the advance organizer, and cognitive level of the test questions. They did not apply any statistical analysis. On the basis of the frequency data, they concluded that the results were inconsistent and inconclusive and that they could not make any generalizations (Barnes and Clawson, 1975, p. 651).

Lawton and Wanska (1977) criticized the Barnes and Clawson review on a number of points. They felt that an adequate statement of Ausubel's theory was not provided. They identified inconsistencies in the various tables in that Barnes and Clawson did not always identify the reasons why certain studies were included in some tables but omitted from others. They also objected to the fact that Barnes and Clawson did not acknowledge the lack of independence among many of the results included in the tables. Barnes and Clawson posed the question, "Do advance organizers facilitate learning?" Lawton and Wanska felt that the superficial treatment of the data provided in the review did not justify any conclusions related to this question.

In their review of the literature on preinstructional strategies, Hartley and Davies (1976, pp. 254-256) gave a brief review of twenty-five studies on advance organizers. They also concluded that the results were confusing. However, on the basis of this review, it was stated that there was a trend indicating that university students and students with high ability are helped more by advance organizers than students at lower grade levels and students with low ability.

Less extensive reviews have been reported by Cunningham (1972), Blanton and Tuinman (1973), West and Fensham (1974), and Novak (1977, pp. 218-220). Blanton and Tuinman (1973, p. 209) criticized the research reports which they reviewed for insufficient descriptions of the advance organizers and criterion measures used in the research. Novak (1977, p. 219) concluded that "advance organizers function only when new materials are inherently meaningful and some rudimentary concept relevant to the new material already exists in the learner's cognitive structure." He stated that the research has indicated that superior students are less likely to require advance organizers (Novak, 1977, p. 220). This is contradictory to the conclusion by Hartley and Davies (1976) mentioned earlier in this section.

The literature reviews discussed above have three main limitations. One limitation is that they did not provide a rationale for the selection of research reports to be included in the review. Consequently, very different types of research were sometimes compared. For example, most of the research reports included in the Barnes and Clawson review compared an experimental group receiving an advance organizer with a control group receiving some alternate introduction such as a historical passage. However, the study by Bright (1974), which was included in the review, compared the relative effectiveness of two different advance organizers. This study was listed as a study showing nonfacilitative effects.

A second limitation is that the content of the materials used as advance organizers was not examined. The third limitation is that statistical analysis was not employed to examine relationships between variables. In the analysis of the advance organizer research in the present study, steps have been taken to overcome each of these limitations.

Kinetic Structure

Kinetic structure refers to the serial ordering of information in a communication according to some organizational principle. Kinetic structure coefficients are measures of the extent to which the order of the terms in a communication corresponds to the order defined by an organizational principle (O. R. Anderson, 1971, p. 7). The organizational principle may be a spacial, a chronological or a derived dimension. The two coefficients that were applied in the present study, commonality and progression density, are based on a derived dimension which defines kinetic structure in terms of the relatedness of the adjacent discourse units in the communication. The basic discourse unit is the simple sentence consisting of subject, predicate, and subordinate clauses. The list of verbal elements, words or phrases which contribute to the substantive meaning of the communication, in each discourse unit provide the data for the calculation of the commonality and progression density coefficients. Commonality is a measure of the extent to which adjacent discourse units contain common verbal elements (O. R. Anderson, 1971, p. 13). Progression density is a measure of the rate at which new elements are introduced in a verbal communication (O. R. Anderson, 1971, p. 17). The instructions for identifying discourse units and verbal elements, and the procedures for calculating the commonality and progression density coefficients are outlined in Appendix B which also contains a sample analysis of a short passage.

Typical values of the commonality coefficient for the type of materials normally used in classroom instruction are 0.25 to 0.50 (O. R. Anderson, 1971, p. 20). Huegel (1975, p. 85) analyzed twenty sets of materials from various high school and university science texts. The commonality coefficients for these materials ranged from 0.23 to 0.40. Muehlke (1973, p. 34) analyzed thirty-six lectures on college biology topics and obtained commonality coefficients in the range 0.25 to 0.36.

The kinetic structure variables were applied in the analysis of the advance organizers in the present study because of their potential relationship with the learning difficulty of verbal materials. O. R. Anderson (1971, p. 19) felt that materials should be most easily understood when there is a balance between commonality and progression; that is, when the commonality coefficient is about 0.50.

The relationship between commonality and learning difficulty has been investigated experimentally (Anderson and Lee, 1975; Browne, 1972; Trindale, 1972). The procedure followed in these experiments was to write learning passages with high commonality coefficients (about 0.50) and then rearrange the sentences to obtain passages with medium (about 0.35) and low (about 0.20) coefficients. The rearrangement of the sentences was done within subsections of the text so that the main flow of ideas was not drastically altered. All of the above researchers reported results to support the hypothesis that subjects exposed to materials with higher commonality coefficients obtain higher achievement scores.

Affective responses of students to materials with high (0.48) and low (0.29) commonality coefficients have also been examined (Butterworth, 1974). He reported that students indicated that the materials with high commonality coefficients provided greater insight into the subject matter, and that these materials were better organized, more easily understood, and more informative.

Teaching Strategies for Concept Development

Henderson (1976) has designed a model for the analysis of instructional materials for identifying the teaching strategies employed in the development of concepts. In the application of this model, the instructional materials are broken down into segments called instructional moves which present pieces of information that are intended to help clarify the definition of the concept, and the moves are classified as characterization moves (C) or exemplification moves (E). Characterization moves present information about the attributes of the set of elements subsumed by the concept. Exemplification moves identify members or nonmembers of the set of elements subsumed by the concept. A teaching strategy consists of a specific sequence of instructional moves. For example, a series of characterization moves followed by a series of exemplification moves is a CE strategy.

The following discussion describes two experiments which investigated the relative effectiveness of various strategies. Dossey (1976) used CE, CEC, ECE, and EC strategies to teach twelve disjunctive mathematical concepts to college students. The concepts were subdivided along the two dimensions of subject area (algebra and geometry) and concept type (inclusive and exclusive). There were no significant differences between treatments for geometric or exclusive concepts. The CEC strategy was significantly more effective than the ECE strategy for algebraic concepts and for inclusive concepts. In addition, the pooled mean score for the CEC and EC strategies was significantly higher than the pooled mean score for the CE and ECE strategies for inclusive concepts. The achievement scores were higher for the geometric concepts than for the algebraic concepts, and the achievement scores were higher for the exclusive concepts than for the inclusive concepts.

Rector and Henderson (1970) used C, CE, EC, and ECE strategies to teach 11 mathematical concepts to college students. Concept attainment was measured at three levels: level I was knowledge or comprehension, level II was application, and level III was analysis, synthesis, or evaluation. There were no significant differences between treatments for levels II or III. The C strategy was significantly more effective than the other three for level I.

The three studies discussed below were not based on the Henderson model, but they do involve the comparison of different teaching strategies for concept formation. In these studies the effectiveness of definitions or examples alone have been compared with the effectiveness of a combination of the two.

Johnson and Straton (1966) compared the relative effectiveness of five strategies: definition, context sentence, classification, synonyms, and a combination of these four in which the order of presentation was definition, synonym, context sentence, and classification. Definition, sentence, and synonym are comparable to characterization moves, and classification is comparable to an exemplification move as defined by Henderson (1976). Therefore, the combined strategy is comparable to a CE strategy in the Henderson model. When treatment time was equated for the five strategies, the combined strategy was significantly more effective than the other four.

Klausmier and Feldman (1973) taught the concept equilateral triangle to grade four students using four strategies: definition (D), three examples and five nonexamples (RS_1), definition followed by three examples and five nonexamples (DRS_1), and definition followed by three sets of three examples and five nonexamples (DRS_{1-3}). The DRS_1 and DRS_{1-3} strategies are comparable to the CE strategy in the Henderson (1976) model. DRS_{1-3} was significantly more effective than D. The time required for the subjects to go through the relevant material varied from treatment to treatment. The time required for the DRS_{1-3} materials was the longest.

In the advance organizer study by Lewis (1972) on Norweigian and Swedish sentence structure, the learning materials presented only examples while the advance organizer presented both examples and definitions. Therefore the advance organizer followed by the learning materials is comparable to a CE strategy in the Henderson (1976) model. Students receiving both the advance organizer and the learning material scored significantly higher on the achievement test than did the subjects receiving only the learning materials.

The results of the above studies tend to indicate that teaching strategies using a combination of characterization and exemplification moves may be more effective than the use of only one or the other. There is also some indication that the sequencing of the characterization and exemplification moves may influence the effectiveness of the strategy. In the present study, the Henderson model was applied in the analysis of the advance organizers to provide a description of the strategies employed in the construction of the advance organizers and to examine the relationship between the advance organizer teaching strategies and the effects obtained through the use of advance organizers with students.

CHAPTER III

RESEARCH DESIGN

This chapter begins with a discussion of the procedures that were followed during the collection of the data. The next two sections describe the sample of studies for which data was obtained and a set of related studies which were not included in the analysis. This is followed by three sections dealing with the variables for which data was collected in the analysis of the sample studies. The final section of this chapter describes the data analysis procedures.

Data Collection Procedures

The procedures followed in the present study were patterned after those described by Glass (1976) in his discussion of meta-analysis. He used the term meta-analysis to refer to research in which previous studies in a particular area serve as the unit of analysis. Meta-analysis is particularly important in areas where large numbers of studies have been done with apparently inconsistent results and where there is a large number of factors which may be affecting the results. A set of variables describing the characteristics of these studies are defined and quantified so that data pertaining to the variables can be obtained for each study. The data is then analyzed by statistical procedures in order to identify patterns and gain insight into relationships that may help to integrate and interpret the reported results.

The data collection procedures can be described in five steps. The first step was a search of the literature to identify research reports on advance organizers. The main sources were Dissertation Abstracts, Education Index, Psychological Abstracts, and ERIC. The bibliographies for each report identified through these sources were examined to locate additional reports. The second step was an attempt to obtain the research materials (advance organizers, learning passages, and achievement tests) which were used in each study. The third step involved the delimitation of the scope of the present study. A set of criteria was established that each study had to meet in order to be included in the analysis. These criteria are discussed in the next section. Each report was then examined to determine whether or not it would be included in the analysis.

The fourth step was the identification of the variables to be used in the analysis. These variables describe the characteristics of the experimental design and procedures, the characteristics of the advance organizers, learning materials, and tests, and the results for each advance organizer research report. Each variable was operationally defined so that quantitative data could be obtained. The final step was the actual coding that was required to generate the data from the research reports and materials.

Sample

The sample consisted of selected reports of advance organizer research. During the initial review of the literature, all reports dealing with advance organizers were examined, but several reports were later dropped from the analysis. Three criteria were established which each report had to meet in order to be included in the analysis.

One criteria was that there must be an experimental comparison between the group receiving the advance organizer and a control group receiving some neutral treatment. Control treatments that were considered to be neutral included introductory passages that did not contain substantive information related to the learning activity and conditions where the control group did not receive an introductory passage. This criterion was selected so that there would be a base level for the identification of the facilitative effect of the advance organizer. That is, the facilitative effect is to be measured in comparison with the absence of the advance organizer rather than in comparison with an alternative type of advance organizer or some other type of activity designed to facilitate comprehension.

A second criterion was that the advance organizer must present a general idea that is intended to act as a subsumer for the learning activity to follow. This presentation must make some attempt to enhance the learner's understanding of the intended subsumer. A simple statement of the topic to be covered was not considered to be sufficient. While a topic identification may have an organizing effect by focusing the learner's attention on the appropriate subsumer, its effectiveness is completely dependent on the presence of this subsumer within the learner's cognitive structure. The present study includes only those reports where the advance organizers have been designed to generate subsumers in the learner's cognitive structure.

A third criterion was that the primary mode of presentation of the information in the advance organizer must be prose. The main reason for this criterion is that the number of non-prose advance organizers is too small to constitute a viable category in the analysis. An additional consideration is that it is more difficult to analyze the content of non-prose materials. For example, it is generally easier to identify what the author has intended to communicate in a prose passage than in a picture.

The final sample for the analysis came from 77 research reports which satisfied the three criteria discussed above. The advance organizer materials were obtained for 59 of these reports. Since a number of the reports contain results for more than one experiment and some advance organizers were used by more than one researcher, the number of sets of advance organizer materials identified in these reports is not equal to the number of reports. A total of 91 sets of materials was identified in the 77 studies retained for analysis. Copies of the advance organizers were obtained for 71 of them.

The advance organizers have been reproduced in Appendix G and the source from which they were obtained is identified. For those which were not obtained, the steps that were taken in the attempt to obtain copies are described. The control introductory passages and the learning activities are also briefly described in Appendix G.

There are five conditions which have resulted in some dependence among the data sets generated from the research reports.

One source of this dependence is the case in which a given researcher has written more than one set of materials. Therefore, his particular biases as to what should be contained in an advance organizer will be reflected in more than one set of data. Seven research reports in the sample gave results for experiments on more than one topic (Billey, 1969; Edwards, 1976; Hershman, 1971; Pucel 1966; Saretsky, 1975; Schulz, 1966; Smith, 1970). Ausubel was the author or co-author for four sets of materials (Ausubel, 1960; Ausubel and Fitzgerald, 1961; Ausubel and Fitzgerald, 1962; Fitzgerald and Ausubel, 1963). Kahle was co-author for two sets of materials (Kahle, 1971; Kahle and Rastovac, 1976). While this situation may be a serious consideration if one is tabulating positive versus negative results for experiments, it is not a problem in the present study because the main focus is to identify relationships among the variables which describe each experiment.

A second source of dependence was due to the use of the same experimental subjects in more than one experiment. There was only one example of this (Hershman, 1971). In this study, the same subjects were used with three sets of experimental materials, but new groupings of subjects were formed for the control and experimental groups for each experiment.

A third factor contributing to dependence among data sets resulted from the fact that some materials were used by more than one researcher. Three examples of this type of overlap were encountered. The Ausubel materials on metal alloys were used in four studies (Ausubel, 1960; R. A. Graber, 1972; Munford, 1971; Young, 1975). The results for these four experiments could not be combined because slightly different versions of the achievement test were used, and other conditions such as the length of time allowed for the subjects to read the materials were varied from study to study. In addition, these four studies did not all report similar results. Ausubel's comparative organizer on Buddhism was used in two studies (Ausubel and Fitzgerald, 1961; Ausubel and Youseff, 1963). The results for these two studies could not be combined because the reported data was not sufficient to enable the calculation of a combined group variance. Four experiments using the island puzzle for network tracing were reported (Peterson, 1971; Peterson, Thomas, Lovett, and Bright, 1973). Three of these were done at the grade 8 level under identical conditions with similar results so the data were combined to give a single data set. Bright used university students so a separate data set was generated for his experiment.

A fourth source of dependence was due to the use of a given advance organizer with more than one learning passage (McMeen, 1974; Townsend, 1969) or the use of more than one advance organizer with a given learning passage (Ausubel and Fitzgerald, 1961; Eastman, 1977; C. J. Graber, 1975; Grotelueschen, 1967 Hartje, 1974; Jerrolds, 1967; Jones, 1977; Koran and Koran, 1973; Murchison, 1975). Since there are only a few variables which describe the learning passage, the second condition does not result in much overlap between data sets.

The fifth source of dependence resulted from the administration of retention tests and the use of blocking variables in the experimental design. When a report gave results for a retention measure, separate sets of data were generated for the immediate achievement and for each retention measure. There were 33 experiments in which retention scores were reported. This resulted in 36 additional sets of data. Additional data sets were also generated when ability and grade level were used as blocking variables. A separate data set was generated for each ability level. There were 32 experiments in which ability was used as a blocking variable and this resulted in 77 additional data sets. In each case, a data set was also generated for the total group of subjects. When grade level was used as a blocking variable, the results were most often collapsed across grade levels to give a single data set. There were two cases in which this was not done because there was a large difference between the grade levels. The report by Peterson, et. al. (1973) gave results for grade 8 students and for university students so two data sets were generated. Barron (1970) reported results for grades 6-12. Rather than generate seven data sets, the results were combined for grades 6-8 and for grades 9-12 to give two sets of data.

The last three sources of dependence mentioned above all influence the results by generating multiple sets of data for which there is an overlap of some portion of the data. For example, if separate data sets are obtained for more than one experiment in which a particular advance organizer was used, all of these data sets will have identical values for the variables which describe the characteristics of the advance organizer. The most frequent occurrence of this type of overlap is with the data sets for retention measures and for various ability levels. The additional data sets generated under these conditions were not included in the main analysis. These additional data sets were used in separate analyses to determine whether or not advance organizers showed differential effects for achievement versus retention measures and for different ability levels. Therefore a large portion of the dependent data sets were omitted from the main analysis.

The main effect of the remaining data sets with overlapping data will be to inflate the correlation coefficients among some of the independent variables. However, the main focus of the present study is to determine what variables may be predictive and explanatory of the effects obtained by using advance organizers which will be accomplished through an examination of the relationships between the independent and dependent variables. Since each data set has unique values for the dependent variables, these relationships will not be directly influenced by the lack of independence among the data sets.

Studies Omitted from the Analysis

A number of research reports on advance organizers were not included in the analysis for the present study because they did not meet the three criteria discussed in the preceding section. The first criteria required an experimental comparison between an advance organizer group and a control group. In many experiments, the relative effects of different treatments were compared and control groups were not used. The most common example of this was the advance versus post organizer experiment in which exposure to the organizer materials prior to the learning materials was compared to exposure to the organizer materials after the learning materials (B. W. Anderson, 1974; Barnes, 1972; Bayuk, et. al., 1970; Davis, 1969; Lesh, 1976a; Lesh, 1976b; Lesh and Johnson, 1976; Steinbrink, 1970; Woodward, 1966). In other experiments, advance organizers were compared to pre-test questions or behavioral objectives (Andrews, 1971a; Dvergsten, 1971; Omura, 1971; Wolk and Svoboda, 1975). Some experiments compared the relative effects of different types of advance organizers (Bright, 1974; Proger, et. al., 1970; Sherman, 1975; Sowder, et. al., 1973; Treizenberg, 1967). In some cases, the introductory passage given to the control group resembled an introductory overview containing a considerable amount of information related to the learning materials (Allen, 1970a; Ethirveerasingam, 1971; Shmurak, 1974).

Another set of research reports which failed to meet the first criterion is those in which the effect of the advance organizer was confounded by some other potential treatment effect. In some cases the advance organizer group received other learning aids such as study guides, behavioral objectives, or pre-test questions which the control group did not receive (Baker, 1974; Bowman, 1975; Hustuft, 1970; Kalt and Barrett, 1973; Walker, 1975). In one experiment, the advance organizer group used a concrete model during the learning activities while the control group did not (Mayer, 1976a).

The second criterion required that the advance organizer present information designed to enhance the learners' understanding of the intended subsumer. Materials that do not meet this criterion include behavioral objectives (Duchastel, 1973; Maher, 1975; Yawkey and Dashiell, 1973), pre-test questions (Dwyer, 1971), and vocabulary lists (Abramson and Kagen, 1973). Studies in which the advance organizer materials contained only an identification of the topic to be covered in the learning passage were also omitted (Van Blaricom and White, 1976; Christie and Schumacher, 1975; Schumacher, et. al., 1974).

The third criterion required that the main mode of presentation of the information in the advance organizer be prose. Three studies were omitted because pictures were used as advance organizers (Farr, 1975; Ghattas, 1970; Hall, 1977). One study using a simulation game for an advance organizer was omitted (Livingston, 1970).

A number of other studies were omitted for various reasons. In two studies, all of the subjects received the same advance organizer, but different learning passages were used for the different treatment groups (Clark and Farley, 1973; Lucking, 1975). Two studies were omitted because of unique characteristics of the experimental subjects. Blackhurst (1974) used EMR students, and Miller (1976) used delinquent teenagers. In two studies, the main focus was to examine what students learned from exposure to the advance organizer materials (Baylis, 1975; Lawton, 1977). The study by Caille (1974) was omitted because it was written in French. The study by Zuck (1974) was omitted because of the length of the advance organizer materials. They required ten hours of instruction and the students in the advance organizer group felt that they were being penalized because the control group was allowed to work on the learning materials during this time (Zuck, 1974, p. 85). Since this advance organizer was so much longer than any of the others in the analysis, this study was omitted. The next longest advance organizer required two hours of instruction.

Some studies which met all three criteria for inclusion were omitted because the dependent variables used in the analysis in the present study could not be computed. Four studies did not report any data which could be used to calculate the magnitude of the difference in achievement between the experimental and control groups (Andrews, 1971b; Barron and Cooper, 1973; Estes, 1971; Proger, et. al., 1973). Three dissertations were obtained for use over a limited time period (Dapra, 1972; Gubrud, 1970; Tyrell, 1973). After they had been returned, the data required for the computation of the dependent variables were misplaced.

In the experiment reported by Nixt (1972), the advance organizers were given to the students during a seminar class period for which there was a high absentee rate. In one analysis of the data, all the subjects in the original sample were retained. Therefore, a number of subjects that were placed in the advance organizer group did not get the advance organizers and thus received the same treatment as the control group. In a second analysis of the data, those subjects in the advance organizer group who were absent from the seminar classes were omitted, but subjects in the control group who were absent from the seminar classes were not omitted. Since the data required to make the appropriate contrast between experimental and control groups was not available, this study was not included in the analysis.

Rationale for the Selection of the Variables and Hypothesized Relationships

In this section, the reasons for the inclusion or exclusion of various variables during the data collection are discussed. Operational definitions for the variables are given in the next section.

A major decision that was made with respect to the variables concerned the identification of the dependent variable. For the purposes of the analysis, the dependent variable must identify the extent to which a particular advance organizer facilitated learning from a particular set of learning materials. In literature reviews, the most common approach to dealing with this is simply to indicate whether or not there was a significant difference between the treatment groups. However, a large portion of the available information is lost in this dichotomous representation of the results. A continuous variable would be more representative of the actual variance in the results of the reported experiments.

Glass (1976, p. 6) recommended a computation which gives the separation between the obtained means for the treatment groups in terms of standard deviations--the mean for the experimental group minus the mean for the control group divided by the standard deviation for the control group. Unfortunately, means and standard deviations are often omitted from research reports. For the analysis in the present study, the decision was made to use the t-statistic (Ferguson, 1959, p. 167) rather than the computation recommended by Glass. It was found that this statistic could be more readily estimated from the given data in reports which omitted means and standard deviations. For example, if analysis of covariance had been used to test for significant differences between two groups, the t-statistic could be estimated by taking the square root of the F-ratio for the analysis. A second dependent variable, which was calculated from the probability level associated with the obtained t-statistic, was identified. This second variable was included to provide some indication of the extent to which the findings of a meta-analysis research project may vary according to the selection of the dependent variable.

Since the dependent variables in the present study are not used in the probabilistic sense normally associated with these statistics, it is not necessary to conform to the limitations placed on their use in multiple comparisons. They are used as a measure of the magnitude of the observed difference between the means for two groups rather than to assign probabilities for the acceptance or rejection of a null hypothesis. There are a number of situations in which multiple t-statistics were calculated for a given research report. When ability was used as a blocking variable, separate t-statistics were calculated for each ability level and for the total group. When retention tests were given, t-statistics were calculated for immediate achievement and for each retention measure. When more than one treatment group was compared to a single control group, separate t-statistics were calculated to compare each treatment group with the control group. Parallel situations were encountered in research reports for which the t-statistic had to be estimated from cell means and analysis of variance summary tables. When multiple data sets were generated from one research report, the contrast for orthogonal comparisons was used as an estimate of the t-statistic (Winer, 1962, p. 691). Of the various post hoc tests available, this contrast is probably the closest approximation to multiple t-tests. Since this contrast is distributed as an F-ratio, its square root is distributed as a t-statistic.

Three variables associated with the computational procedures for calculating the dependent variables were identified to determine whether or not these factors were creating any consistent biases in the obtained values for the dependent variables. One of these variables is the total number of subjects in the two groups for which the t-statistic was calculated. This variable is of particular interest in relation to the dependent variable computed from the probability level because the probability level of significance associated with a given value of the t-statistic depends on the degrees of freedom. This variable was included to determine whether or not studies with larger samples showed a greater tendency to find significant differences. The other two variables relate to the procedures that were used to estimate the t-statistic when the means and standard deviations were not available. One variable identified all those cases for which the t-statistic was not calculated from means and standard deviations. The other variable identified the subset of these cases for which covariance analysis was employed.

The independent variables were selected so as to provide a detailed description of the conditions of the experimental setting and of the characteristics of the experimental subjects and materials for each advance organizer report. Many of these variables were identified through reading literature reviews of advance organizer research and through a preliminary scanning of the original reports. In addition, extensive descriptive notes were kept on each report as it was read in detail. These notes helped to identify conditions and characteristics that were varied from experiment to experiment. Examples of variables that were identified through these procedures are the grade level and ability level of the subjects, the cognitive level of the questions in the test used as the criterion measure, the subject area, the type of concept presented in the advance organizer, the presentation mode for the advance organizer and learning materials, and the length of the treatment.

There is some disagreement concerning the best way to deal with research reports with serious design problems when conducting a meta-analysis. Mansfield and Busse (1977) feel that the researcher doing the meta-analysis should make a judgement as to the quality of research that will be considered acceptable and then omit all those reports which fail to meet the specified standard. Glass (1976, p. 4) feels that literature reviews have tended to place too much emphasis on design problems and that the personal biases of the researcher may affect the decisions concerning which reports to retain for the analysis. Glass feels that the meta-analysis should include as many reports as possible. In the present study, a number of variables describing the quality of research were identified. Rather than dropping those research reports with design problems, all reports were retained and the quality of research for each report was defined by this set of variables. The extent to which design problems were related to the results was then determined through the data analysis.

The relationships of all of the independent variables with the dependent variables were examined to identify conditions and characteristics that may be predictive and explanatory of the effects obtained through the use of advance organizers. However, some specific relationships were predicted prior to the data analysis. These predictions have been previously identified in the form of the hypotheses stated in Chapter I. These hypotheses will be discussed in further detail at this point to provide a rationale for the selection of some of the independent variables and for the stated hypotheses.

Hypotheses 1 through 7 are all based on the contention that students cannot be expected to benefit from an advance organizer unless they can understand the information presented in it. Of the sample studies included in the analysis, only one (Malone, 1970, p. 43) examined the level of understanding of the advance organizer material attained by the subjects. Since actual measures of this level of understanding are not available, a number of variables were identified to provide an indirect examination of this factor.

Hypotheses 1 and 2 pertain to variables which describe characteristics of the experimental subjects. A preliminary scan indicated that the experimental treatments generally involved a fairly short exposure to an advance organizer with a fairly high concentration of information. For this reason, it was felt that students at lower grade levels and with lower learning abilities may have had trouble dealing with these materials. Hypotheses 1 and 2 respectively predict that there will be a greater tendency for advance organizers to show facilitative effects for students at the higher grade levels and with higher learning abilities.

Hypothesis 3 deals with the gain score for the control group. The gain score was obtained by taking the achievement score minus the prior knowledge score. This is a measure of how much was learned from the learning materials, but it can also be considered as an estimate of the learning difficulty of the advance organizer. If the learning materials were difficult to understand, it is quite probable that the advance organizer was also difficult. The gain score for the control group was used to avoid the possible interaction effect of advance organizer and learning materials combined. Hypothesis 3 predicts that the tendency for the advance organizers to show facilitative effects will increase as the gain scores for the control groups increase.

Hypotheses 4 through 7 pertain to variables which describe characteristics of the advance organizers which may help the students to better understand the information presented in them. The first of these is reading level. Hypothesis 4 predicts that advance organizers which are written at a reading level appropriate for the grade level of the subjects will have a greater tendency to show facilitative effects.

Hypotheses 5 and 6 pertain to the kinetic structure variables, commonality and progression density. These variables were included in the analysis because of their potential relationship to the ease with which reading materials can be understood. Reading materials should tend to be more easily understood as the coefficient of commonality increases and as the coefficient of progression density decreases. The literature related to these variables has been discussed in Chapter II. Hypotheses 5 and 6 respectively predict that advance organizers with higher commonality coefficients and lower progression density coefficients will have a greater tendency to show facilitative effects.

Hypothesis 7 predicts that advance organizers in which a combination of exemplification and characterization moves, examples and definitions, are used to develop the main concepts will have a greater tendency to show facilitative effects than will advance organizers which present only one or the other. The literature in support of the theory that concepts are more readily learned from a combination of examples and definitions has been discussed under the topic of teaching strategies in Chapter II.

Hypothesis 8 predicts that studies in which the main ideas from the advance organizer are repeated in the learning materials will have a lesser tendency to show facilitative effects. This variable was included to provide some indication of the extent to which the materials used as advance organizers tend to resemble introductory overviews. Since an introductory overview is generally an attempt to summarize or condense a more lengthy learning passage, the ideas presented in it are likely to be repeated in the learning passage. Ausubel (1970, p. 3) stated that an advance organizer should not be an introductory overview of the information presented in the learning passage. Another factor to be considered in relation to hypothesis 8 is the possibility that a learning passage itself might achieve the function which is to be served by the advance organizer. If the general ideas presented in the advance organizer are appropriately placed within the learning passage, they could possibly have the same effect as exposure to the advance organizer. In these cases, both the control and the experimental groups would have experienced some form of the advance organizer.

Some variables describing characteristics of the learning materials were initially considered for the analysis but were later dropped because of the amount of time required to code the data and the difficulty in obtaining copies of the learning materials. In many cases, classroom activities were used for which there were no recorded scripts. The variables that were dropped were descriptions of the teaching strategies employed to develop the concepts in the learning materials and measures of the appropriateness of the intended subsumer presented in the advance organizer for the information contained in the learning materials.

Operational Definitions for the Variables

The operational definitions that were used for the generation of the data from the research reports and materials are presented in this section. The main grouping of the variables divides them into dependent and independent variables. The variables are numbered from 1 to 65 and this numbering system is maintained throughout the remainder of the dissertation.

The two dependent variables are measures of the magnitude of the difference between the achievement means for the advance organizer and control groups. The first variable is the t-statistic for testing for significant differences between two means and the second is based on the probability level associated with the obtained t-statistic.

1. t-statistic: It was computed by the following formula (Ferguson, 1959, p. 167):

$$t = \frac{\overline{AO}-\overline{C}}{\sqrt{s^2/NAO + s^2/NC}} \text{ where } s^2 = \frac{(NAO-1)VAO + (NC-1)VC}{NAO+NC-2}.$$

$\overline{AO}$, NAO, VAO, $\overline{C}$, NC and VC are the means, sample sizes, and variances for the advance organizer and control groups respectively. For cases in which the data required for the computation of the t-statistic were not available, the t-statistic was estimated from other statistics. The estimates that were used are the square root of the F-ratio from an analysis of variance or covariance and the square root of the contrast for orthogonal comparisons computed from the group means and error term from an analysis of variance or covariance (Winer, 1962, p. 69):

$$\frac{(\overline{AO}-\overline{C})^2}{(1/NAO + 1/NC)MS_{error}} \sim F$$

For analysis of covariance, adjusted means were used. Since this contrast is distributed as an F-ratio for which the degrees of freedom for the numerator are 1 and the degrees of freedom for the denominator are taken from the error term, the square root of this constrast will be distributed as a t-statistic. A negative value was assigned to the estimate for cases in which the mean for the control group was higher than the mean for the advance organizer group.

2. Probability: The t-statistic was converted to an F-ratio and a computer program was used to compute the probability level associated with it (α). For cases with the advance organizer group mean higher than the control group mean, variable 2 = $(1-\alpha)$. For the opposite condition, variable 2 = $-(1-\alpha)$. This generates a variable with values ranging from -1 to +1. Larger positive values indicate a greater facilitative effect for the advance organizer.

The independent variables have been classified into five categories: characteristics of the sample, treatment administration conditions, type of subject matter to be learned, quality of the research procedures, and characteristics of the advance organizers and learning materials. Variables 3-5 do not fit under any of these categories.

Variables 3 and 4 identify those cases for which the data required for the computation of the t-statistic were not available.

3. Estimated t: The t-statistic was estimated rather than computed from means and variances: (yes=1; no=0).

4. Covariance: Analysis of covariance was used in the calculation of the dependent variables: (yes=1; no=0). These cases are a subset of those identified by variable 3.

5. Date: This is the date of publication for the research report. Only the last two digits of the date were used. If more than one publication of a given experiment

was identified, the earliest publication date was used.

Characteristics of the Sample: These variables describe some of the entering characteristics of the subjects and the level of achievement that they attained through participation in the experiment.

6. Sample Size: This is the total number of subjects in the advance organizer and control groups combined for which the t-statistic was computed.

7. Grade level: This is the grade level of the subjects. All post-secondary students were identified as grade 13. When the data were combined for subjects from more than one grade level, the average for all the grades represented was taken. A weighted average was considered, but it was not used because there were no cases with large differences in the numbers of students in each grade.

8. Learning Ability: A scale of 1-5 for which 5 is high was established to identify the learning abilities of the subjects. These scale values were assigned according to the specification of high, medium, and low ability groups in the experimental design. If three ability groups were identified, scale values 1, 3 and 5 were used. If two ability groups were identified, scale values 2 and 4 were used. When four ability groups were identified, the two middle groups were combined and scale values 1, 3 and 5 were used. A wide variety of measures were used by researchers to block subjects on learning ability. The three most common

ones were IQ tests, basic skills tests, and reading tests.

9. Prior Knowledge: Two sources of data were used to determine the extent to which the subjects understood the information covered by the criterion measure prior to the experiment. In some experiments, a group of subjects was given the criterion measure but no treatment, and subjects were sometimes given the criterion measure as a pre-test. The mean score for all the subjects who took the test with no exposure to the materials was converted to a per cent and used as a measure of prior knowledge.

10. Level of Achievement: The mean scores on the criterion measure post-test for the advance organizer and control groups were pooled and converted to a per cent.

11. Gain Score: The gain score is a measure of how much the students learned from learning materials alone. It was computed as the mean score in per cent for the control group on the criterion measure post-test minus the prior knowledge score calculated for variable 9.

Treatment Administration Conditions: These variables describe a variety of properties and procedures pertaining to the administration of the experiments. Some of them are somewhat descriptive of the materials, but they were included in this group because they describe physical rather than substantive qualities.

12. Number of Advance Organizers: In some experiments, the treatment group was given more than one advance

organizer and each organizer was presented at the beginning of the section of the learning materials to which it applied. Variable 12 is a count of the number of advance organizers used with a given treatment group.

13. Times to Read AO: This is a count of the number of separate meetings at which the subjects received a given advance organizer prior to getting the learning materials.

14. AO During LM: This is a dichotomous variable which identifies those cases for which the subjects were allowed to refer to the advance organizer while they worked on the learning materials: (yes=1; no=0).

15. Have AO Outside: This is a dichotomous variable which identifies those cases for which the subjects had access to the advance organizer outside of the experimental setting: (yes=1; no=0).

16. Control Introduction: This is a dichotomous variable which identifies those cases for which the control group was given a control introduction in place of the advance organizer: (yes=1; no=0). Alternatives to the use of a control introduction were to have the control group do nothing or work on the learning materials while the experimental group was given the advance organizer.

17. Pre-test: This is a dichotomous variable which identifies those cases for which the subjects were given the criterion measure as a pre-test: (yes=1; no=0).

18. Retention Test: This is a dichotomous variable which identifies those cases for which the dependent variables were computed from the results of a retention test: (yes=1; no=0).

19. Retention Time: This is the number of days between the achievement test and the retention test.

20. Length of the AO in Words: This is the number of words in the advance organizer. All words were counted.

21. Length of the AO in Minutes: This is the total number of minutes that the subjects were allowed to study the advance organizer.

22. Length of the LM in Words: The number of words in the learning materials was estimated by multiplying the number of words per page by the number of pages.

23. Length of the LM in Minutes: This is the total number of minutes that the subjects were allowed to study the learning materials.

24. AO Length/LM Length: This is the ratio of the length of the advance organizer to the length of the learning materials. This ratio was computed for the lengths in both words and minutes and the average of these two values was used. If only one of these ratios could be computed, then that value was used.

Subject Matter: These variables identify the subject area, describe the concepts contained in the advance organizer, and specify the cognitive level of the test questions in the criterion measure. Variables 25-27 are dichotomous variables (1,0) which identify the subject area. The specific categories to be used were selected so that there would be a reasonable number of studies in each subject category.

25. Science: This includes chemistry, physics, biology, the earth sciences, and technology.

26. Mathematics: This includes algebra, geometry, calculus, and statistics.

27. Other Subjects: These are all the topics which are not science or mathematics. The subject areas that were included in this category are psychology, education, social studies, language, religion and the arts.

28. Concept Type: The major concepts presented in each advance organizer were identified and classified according to function as defined by Pella (1966, p. 33). He classified concepts as classificational, correlational, or theoretical. A classificational concept facilitates the description of phenomena through the specification of attributes that can be used to classify objects and events. A correlational concept facilitates the prediction of events, and a theoretical concept facilitates the explanation of phenomena. Variable 28 is a dichotomous variable for which 0 identifies the concepts as classificational and 1 identifies them as correlational or theoretical. In the specification of the concepts to be classified, only the

most general concepts were identified. Any concept in the advance organizer that could be subsumed under a more general one was not identified. For example, in an advance organizer having mathematical group as the main concept, other concepts such as set and binary operation used in the definition of group would not be identified for classification. When more than one concept was identified, variable 28 was coded 0 only if all concepts were classificational. Variable 28 was not coded if a copy of the advance organizer was not available because the classification of each concept was based on the way it was presented in the advance organizer. For example, equilibrium could be presented as a classificational concept for the purpose of classifying systems or as a correlational concept for predicting changes in a system.

29. Number of Concepts: This is the total number of major concepts that were identified for variable 28.

30. Number of Attributes: The attributes used to define each concept (variable 28) in the advance organizer were counted. The term attribute was broadly applied to refer to any property contributing to the definition of the concept and no attempt was made to distinguish between critical and non-critical attributes. Variable 30 is the average number of attributes per concept.

31. Cognitive Level of the Test: The questions on the achievement test used as the criterion measure were

separated into two categories: those that were specifically answered in the learning materials (recall questions) and those that were not (higher level questions). Variable 31 is a percentage representing that portion of the test composed of higher level questions.

Quality of the Research Procedures: Variables 32-40 are based on the model for judging the quality of research procedures developed by Gephart and Bartos (1969). Three broad areas are represented in their model: the structure of the logical argument, the adequacy of the data collection procedures, and the appropriateness of the statistical analysis of the data. For the analysis in the present study, three variables in each category were defined, but they were regrouped into two categories. Those pertaining to the logical argument were relabelled internal validity variables. Those pertaining to data collection and analysis are grouped in the category of external validity variables.

The internal validity variables describe procedures employed to deal with alternate hypotheses that are not related to the role of subsumers in meaningful learning for the facilitative effects of advance organizers. Variables 32 and 33 relate to the possibility that exposure to the advance organizer alone could assist in answering the test questions. Variable 34 relates to the possibility that the facilitative effect could be due to a time factor.

32. Per Cent of Test Answerable by AO: This is a percentage which represents that portion of the test which the information presented in the advance organizer alone could help to answer.

33. Experimental Test of Alternate Hypothesis: This is a dichotomous variable which identifies those cases for which an experimental test was conducted establishing that subjects reading only the advance organizer did not score significantly higher on the achievement test than did subjects reading only the control introduction or nothing: (yes=1; no=0).

34. Time Equalization: This is a dichotomous variable which identifies those cases for which the control group studied the learning materials for a period of time equal to the combined time that the experimental group studied the advance organizer and learning materials: (yes=1; no=0).

Of the external validity variables, variables 35-37 deal with the adequacy of the data collection procedures and variables 38-40 deal with the appropriateness of the data analysis.

35. Representativeness of the Sample: This was specified on a scale from 1 to 4 for which the scale values represent the following sampling procedures:

4-random sampling from a well defined population.
3-use of an intact group which was convenient.
2-use of volunteers.
1-no description of sampling procedures.

36. Loss of Sample: This is the per cent of the initial sample which was lost due to absenteeism and missing data.

37. Quality of the Achievement Test: This is a scale from 3 to 9 based on the reliability, validity, and objectivity of the achievement test. The three separate scales identified below were coded and the three values were summed to give the scale value for variable 37.

reliability:
- 3-KR20 > 0.87
- 2-$0.87 \geq$ KR20 > 0.74
- 1-KR20 ≤ 0.74
  (Subtract 1 if reliability sample was not equivalent to experimental sample).

validity:
- 3-use of judges with 95% agreement.
- 2-use of judges with less than 95% agreement or no results given.
- 1-no validity check.
- 0-obvious violations of content validity.

objectivity:
- 3-totally objective items or more than one scorer with 95% agreement for subjective items.
- 2-more than one scorer for subjective items with less than 95% agreement or at least 50% objective items.
- 1-only one scorer for a test with more than 50% subjectively scored items.

38. Wrong Unit of Analysis: This is a dichotomous variable which identifies those cases for which an inappropriate unit of analysis was used: (yes=1; no=0). The procedures that were classified as inappropriate were the use of student as the unit of analysis when classes were assigned to treatment groups or when a treatment involving classroom interaction was presented separately to groups

consisting of only experimental or control subjects.

39. Type I Error: This is a dichotomous variable which identifies those cases in which the analysis procedures would tend to increase the probability of making a type I error: (yes=1; no=0). These include the use of multiple t-tests rather than analysis of variance, the use of inappropriate post hoc tests, and the failure to make a multivariate test for five or more criterion variables.

40. Type II Error: This is a dichotomous variable which identifies those cases for which the analysis procedures would tend to increase the probability of making a type II error. These include the failure to use repeated measures analysis, and the failure to use blocking variables when these procedures are indicated: (yes=1; no=0).

Characteristics of the Materials: The characteristics of the advance organizers and learning materials described by the variables in this group are type of advance organizer, presentation mode, reading level, kinetic structure, and teaching strategy. Some variables describing physical characteristics of the materials such as treatment length were included in the group of variables describing the treatment administration conditions.

41. Type of Advance Organizer: Ausubel and Fitzgerald (1961, p. 266) defined two types of advance organizers: expository and comparative. An expository organizer should be used when the new material is completely unfamiliar to the

learner. Familiar vocabulary and concrete examples should be used to establish a subsumer to which the new material can be related. A comparative organizer should be used when the new material represents a variant of some related concepts which have been previously learned. It should identify similarities and differences between the concepts which are already a part of the learner's cognitive structure and those presented in the new materials. Variable 41 is a dichotomous variable for which 0 specifies an expository organizer and 1 specifies a comparative organizer. In cases for which a copy of the advance organizer was not obtained, the coding was based on the author's description. In some cases the author's description was not detailed enough to enable coding.

Presentation Mode: Variables 42 and 46 identify the basic mode of presentation for the advance organizer and learning materials respectively. Variables 43-45 and 47-49 identify more specific characteristics.

42. Presentation Mode for the AO: This is a dichotomous variable which identifies the mode of presentation for the advance organizer according to the following codes:

0 - students read the advance organizer or listened to someone else reading it from text in class, or on tape or TV monitor.

1 - the advance organizer was presented through classroom instruction with interaction,

programmed instruction, audio-tutorial sessions, in a laboratory setting, or in combination with audio-visual aids.

43. Concrete Experience in AO: This is a dichotomous variable which identifies those cases for which the advance organizer contained a reference to a concrete experience or provided the opportunity for a concrete experience: (yes=1; no=0).

44. Diagrams in the AO: This is a dichotomous variable which identifies those cases for which the advance organizer contained pictures or diagrams: (yes=1; no=0).

45. Questions in the AO: This is a dichotomous variable which identifies those cases for which the advance organizer contained review questions: (yes=1; no=0).

46. Presentation Mode for the LM: This is a dichotomous variable which identifies the mode of presentation for the learning materials according to the same coding used in variable 42.

47. Laboratory Work in LM: This is a dichotomous variable which identifies those cases for which learning activities had laboratory work or demonstrations: (yes=1; no=0).

48. Questions in the LM: This is a dichotomous variable which identifies those cases for which the learning materials contained review questions: (yes=1; no=0).

49. Control of LM: This is a dichotomous variable which identifies those cases for which the learning

activities were not completely planned by the researcher conducting the experiment: (yes=1; no=0).

Reading Level: The Fry (1968) method for determining reading level was used. The instructions for this method are outlined in Appendix A.

50. Appropriateness of the Reading Level of the AO: This is the reading level of the advance organizer divided by the grade level of the subjects.

51. Appropriateness of the Reading Level of the LM: This is the reading level of the learning materials divided by the grade level of the subjects.

Kinetic Structure: Kinetic structure analysis examines the serial ordering of information in a verbal communication and the relatedness of the adjacent discourse units in the communication (O. R. Anderson, 1971, p. 7). The basic discourse unit is the simple sentence consisting of subject, predicate, and subordinate clauses. The list of verbal elements, words or phrases which contribute to the substantive meaning of the communication, in each discourse unit provides the data for the calculation of the kinetic structure coefficients. The procedures for identifying discourse units and verbal elements are outlined in Appendix B which also contains a sample analysis. The two kinetic structure variables used in the analysis are commonality and progression density.

52. Commonality Coefficient: Commonality is a measure of the extent to which adjacent discourse units contain common verbal elements. The coefficient used in the analysis is the fundamental coefficient (B_1) defined by O. R. Anderson (1971, p. 13). In the calculation of the coefficient for the advance organizers, the ratio n_c/n_t was computed for each adjacent pair of discourse units: n_c is number of elements that the two discourse units have in common, and n_t is the total number of elements in the two discourse units. Elements that appear in both discourse units must be counted twice when obtaining the values for n_c and n_t. When the advance organizer consisted of more than one passage, the coefficient was obtained for each passage and an average, weighted according to the relative lengths of the passages, was used.

53. Progression Density Coefficient: Progression density is a measure of the rate at which new elements are introduced in a verbal communication. The procedures outlined above for the calculation of the commonality coefficient were also used for the calculation of the progression density coefficient. For progression density, the coefficient for adjacent pairs of discourse units is $(1-B_1)n$ where B_1 is the commonality coefficient for the pair and n is the number of elements in the second member of the pair which do not appear in any previous discourse unit (O. R. Anderson, 1971, p. 17).

Teaching Strategy: The procedures used to identify the teaching strategies employed in the development of the major concepts in the advance organizers were based on the model described by Henderson (1967). This model provides a guide for the analysis of instructional materials designed to teach concepts. The first step requires that the materials be blocked off into instructional moves which are segments of the materials pertaining to one attribute or example of the concept. These moves are then classified as exemplification moves or characterization moves. Exemplification moves provide examples or nonexamples and characterization moves provide descriptions of the attributes of the concept (Henderson, 1967, pp. 575-577). A third category of moves, moves in the metalanguage, was also defined, but this category was not used in the analysis in the present study because it was too difficult to distinguish between characterization moves and moves in the metalanguage. In the final step of the analysis, the instructional moves are placed in clusters. The teaching strategies are defined by the sequence of exemplification and characterization moves in each cluster. The instructions for identifying moves, classifying moves, and identifying strategies are outlined in Appendix C which also contains a sample analysis.

In the present study, the teaching strategies employed in the advance organizers were specified with respect to the major concepts in the advance organizer as identified for variable 28. That is, only those moves pertaining to the major concepts were used to define the strategies. Instructional moves pertaining to the subconcepts were tabulated but not considered in the identification of the strategies. This distinction is discussed in more detail with examples in Appendix C.

Variables 54-59 pertain to the instructional moves that were identified in the advance organizer.

54. Number of Moves: This is the total number of moves pertaining to the major concepts.

55. Per Cent Characterization Moves: This is the number of characterization moves divided by the total number of moves and converted to a per cent. Only those moves pertaining to major concepts were included.

56. Tendency Toward 50-50 Split for the Moves: This variable was derived from variable 55 and its values range from zero to fifty where zero indicates that the moves were either all exemplification or all characterization and fifty indicates that there were an equal number of both types. If variable 55 was greater than fifty, variable 56 was set equal to one hundred minus variable 55; otherwise, variable 56 was set equal to variable 55.

57. Per Cent Moves Repeated in LM: This is a percentage which represents that portion of the major concept moves that were repeated in the learning materials.

58. Subconcept Moves: This is the total number of moves pertaining to the subconcepts.

59. Per Cent Major Concept Moves: This is variable 54 divided by the sum of variables 54 and 58 converted to a per cent.

Variables 60-65 identify the teaching strategies.

60. Pure Strategy: This is a dichotomous variable which identifies those cases in which the major concept moves were all characterization or all exemplification moves: (yes=1; no=0).

Variables 61-65 specify the per cent of the major concept moves included in a particular strategy. The number of moves contained in the specified strategy were counted and divided by the total number of moves. The sequence of moves in each strategy is specified by a C for characterization and an E for exemplification. The critical factor in the identification of a given set of moves as one strategy or another is the first and last move in the sequence. For example the sequence of moves, CEECEC, would be classified as a CEC strategy.

61. Per Cent of Moves in E or C strategy.

62. Per Cent of Moves in CEC strategy.

63. Per Cent of Moves in EC strategy.

64. Per Cent of Moves in CE strategy.

65. Per Cent of Moves in ECE strategy.

Reliabilities for Coding Procedures Used in Data Collection

Rater stability and inter-rater agreement estimates were obtained for the variables requiring subjective judgements in the coding procedures used to obtain the data. The following discussion first describes the procedures that were used to obtain the data for establishing these estimates. The obtained values for each variable are then presented.

Rater stability estimates were obtained from comparisons of the results from two separate analyses of selected sets of materials. This was done at two points during the data collection. The first step was the analysis of three sets of materials which were selected to be used in establishing rater stability estimates. After an additional twenty-seven sets of materials were analyzed, a period of six weeks, the first three were analyzed a second time. At this point, another three sets of materials were selected and analyzed. After the remaining forty sets of materials were analyzed, this second set of three were analyzed a second time. Only sets of materials for which copies of the advance organizers, learning materials, and achievement tests were available were selected for the rater stability analysis. The six studies from which the materials were selected are Bonner (1974), Montano Midence (1974), Smith

(1970), Brovey (1969), Callihan (1975), and Fitzgerald (1962). The first three listed are the first group of three to be analyzed. Of the two sets of materials used by Smith (1970) the one on adaptation was used, and the results were pooled for the four advance organizers on this topic. In the selection of these six studies, care was taken so that a variety of subject areas, grade levels, and advance organizer lengths would be represented. The three subject areas, science, mathematics, and social studies are represented by two sets of materials each. University students were used in three studies, and the grade levels of the students used in the other three studies are four, nine and eleven. The shortest advance organizer had 174 words and the longest had 910 words.

Inter-rater agreement estimates were obtained from comparisons of the results for this researcher with those for a second judge. The second judge and the sets of materials used to establish inter-rater agreement estimates were not the same for all of the variables. In the selection of the materials to be used for each variable, care was taken to ensure that a representative range of values would be obtained. The second judges were doctoral students and professors in science and mathematics education. Since all of the coding for the data collection for the present study was done by this researcher, rater stability is more important to the analysis than is inter-rater agreement. Very short training sessions were used to acquaint the second judges with the coding procedures.

Cognitive Level of Test Questions: Test questions were placed in two categories: those that were specifically answered in the learning materials (recall questions) and those that were not (higher level questions).

Rater Stability: Smith (1970) used a cloze test which was classified as 100% recall so it was not included in the computation. Table 1 presents the data for the other five tests. Per cent agreement is based on the number of questions for which the classification was the same for both analyses rather than on the total number of questions identified as recall for each analysis. The per cent agreement considering all items is 94.

TABLE 1

RATER STABILITY DATA FOR COGNITIVE LEVEL

		Recall Questions		
Source	Number of Questions	First	Second	Per Cent Agreement
Bonner	12	6	7	92
Montano	18	5	5	100
Brovey	24	7	6	87
Callihan	15	2	3	93
Fitzgerald	34	10	10	88
(total)	103	30	31	94

Inter-rater Agreement: A second judge classified 31 items that were randomly selected from three tests. This total was made up of sixteen from Hartje (1974), six from Schnell (1973a), and nine from Toth (1975). Approximately 40% were recall items. There was a 90% agreement for the classification of the items.

Quality of the Research: Most of the variables in this category were defined so that subjective judgements were not required during the coding. While subjective judgements were made in establishing some of the categories, the definitions were objectively applied during the data collection. The only variable in this category for which this is not true is variable 32, which is the per cent of the test questions which are answerable from the information provided in the advance organizer. The judgement required for each test question is whether or not the information in the advance organizer would help to answer it.

Rater Stability: The test used by Clawson (1972a) was used for this computation because the tests for the six studies selected for the rater stability analysis did not have any questions answerable from the advance organizer information. Of the thirty questions classified, 30% were considered answerable from the advance organizer information. There was a 90% agreement between the classifications for the two analyses.

Inter-rater Agreement: A second judge classified the 25 items in the test used by Prescott (1976). There was an 88% agreement for the classification of the items. Forty per cent of the items were classified as answerable from the advance organizer information.

Kinetic Structure: Reliability estimates were obtained for the identification of discourse units and for the identification of verbal elements.

Discourse Units: Of the 178 discourse units identified in the six advance organizers used in the rater stability analysis, there were disagreements on 3 units. There was not more than one disagreement for any one advance organizer. This is a 98% agreement.

Of the 70 discourse units identified in the two advance organizers used in the inter-rater agreement analysis, there was a disagreement on one unit. This is a 98% agreement. O. R. Anderson (1971, p. 29) and Huegel (1975, p. 78) have reported inter-rater agreement percentages of 95 and 96 respectively for the identification of discourse units.

Verbal Elements: Per cent agreement was determined for the identification of unique verbal elements in each advance organizer and for the identification of elements in the discourse units. These percentages were calculated by counting those elements that were identified in both analyses and dividing by the total number of elements identified. The results for both rater stability and inter-rater agreement are presented in Table 2. The results for each advance organizer are presented separately and pooled values are given for the six advance organizers used in the rater stability analysis and for the two advance organizers used in the inter-rater agreement analysis. The pooled values were calculated from the sum of the number of agreements in all the advance organizers divided by the sum of the number of elements identified. The number of elements specified in the table is the number of unique elements identified. The pooled values for the rater stability are 88% and 89% agreement for the identification of unique elements and for the identification of elements in discourse units respectively. The corresponding values for inter-rater agreement are 74% and 76%. The main source of disagreement between judges was that one judge had a greater tendency to group words together in identifying elements. Huegel (1975, p. 78) reported an inter-rater agreement of 93% for the identification of verbal elements.

The commonality and progression density coefficients obtained in the two separate analyses are also given for each advance organizer in Table 2. The per cent error is the difference between the two values for each coefficient divided by the average value converted to a per cent. The average errors for rater stability are 3% and 7% for commonality and progression density respectively. The corresponding values for inter-rater agreement are 6% and 8%.

TABLE 2

RELIABILITY ESTIMATES FOR KINETIC STRUCTURE ANALYSIS

		Per Cent Agreement		Commonality			Progression Density		
	Number of Elements	Unique Elements	Elements in Units	1	2	% Error	1	2	% Error
Bonner	29	86	91	0.36	0.34	6	2.02	2.20	9
Midence	102	84	90	0.30	0.29	3	1.19	1.25	5
Smith	98	90	92	0.34	0.32	6	1.41	1.49	5
Brovey	102	89	84	0.18	0.18	0	2.79	3.06	9
Callihan	69	86	85	0.20	0.21	5	3.70	4.02	8
Fitzgerald	101	89	92	0.19	0.19	0	2.86	2.99	4
(pooled)	501	88	89			(ave) 3			(ave) 7
Allen	61	80	80	0.26	0.29	11	1.84	1.98	7
Kuhn	117	71	71	0.24	0.24	0	1.63	1.78	8
(pooled)	178	74	76			(ave) 6			(ave) 8

The disagreement in the obtained values for the coefficients is generally less pronounced than the disagreement in the identification of the elements. It is the coefficients which were used as variables in the analysis in the present study.

Teaching Strategy Variables: Reliability estimates were obtained for the identification of instructional moves and for the grouping of moves for the identification of teaching strategies. The per cent agreement for the classification of moves as characterization and exemplification was virtually 100%. For the six advance organizers used in the rater stability analysis, there were no disagreements in classification between the two analyses. For the two advance organizers used in the inter-rater agreement analysis, there was one disagreement in classification out of the forty-four moves identified.

Identification of Moves: The results for the rater stability and inter-rater agreement are presented in Table 3. The data presented in Table 3 pertains only to the moves for the major concepts. The advance organizers used in the inter-rater agreement analysis are the one from Barrow (1973) and the Unit IV organizer on force from Tavares (1976). The per cent agreement was calculated by counting those moves that were identified in both analyses and dividing by the total number of unique moves identified. The results for each advance organizer are presented separately and pooled values are given for the six advance organizers used in the rater stability analysis and for the two advance organizers used in the inter-rater agreement analysis. The pooled values were calculated from the sum of the number of agreements in all the advance organizers divided by the total number of moves identified. The number of characterization moves (C) and exemplification moves (E) identified in each advance organizer is also given in the table to illustrate the variety in the type of materials included in this analysis.

TABLE 3

RELIABILITY FOR THE IDENTIFICATION OF MOVES

	No. of C Moves		No. of E Moves		
Source	1	2	1	2	% Agreement
Bonner	3	3	0	0	100
Midence	5	6	6	6	92
Smith	8	9	6	8	82
Brovey	12	12	21	22	91
Callihan	5	5	0	0	100
Fitzgerald	1	1	7	9	80
(pooled)	34	36	40	45	90
Barrow	5	6	5	5	91
Tavares	15	15	18	18	78
(pooled)	20	21	23	23	81

The pooled values for rater stability and inter-rater agreement are 90% and 81% respectively. The main source of disagreement was in deciding whether a particular bit of information should be coded as a major concept move or as a subconcept move. A second source of disagreement was in deciding whether a specific section of the materials should be coded as a single move or as more than one move.

The per cent agreement for the identification of subconcept moves was also determined. For the six advance organizers used in the rater stability analysis, the agreement percentages ranged from 86% to 100% and the overall agreement was 89%. For the two advance organizers used in the inter-rater agreement analysis, the agreement percentages were 78% and 80%.

Another variable related to the identification of instructional moves for which reliability estimates were obtained is variable 57 which is the per cent of moves pertaining to the major concepts in the advance organizer that were repeated in the learning materials. Of the six advance organizers used in the rater stability analysis, only two had moves from the advance organizer repeated in the learning materials (Callihan, 1975; Montano Midence, 1974). Of the seventeen moves in these two advance organizers, nine were judged to be repeated in the learning materials and there was a 100% agreement between the two analyses.

For inter-rater agreement, the moves were marked by the author of the dissertation for three advance organizers (Hartje, 1974; Schnell, 1973a; Toth, 1975) and a second judge was asked to identify those that were repeated in the learning materials. Of the fifty-four moves in these three advance organizers, six were judged to be repeated in the learning materials and there was a 98% agreement between judges.

Identification of Teaching Strategies: For the specification of teaching strategies in the discussion in this section, C and E are used to represent characterization and exemplification moves respectively. For the six advance organizers used in the rater stability analysis, there were no disagreements between the two analyses in the identification of the teaching strategies.

Two approaches were taken in the determination of inter-rater agreement. In the first, the judge who identified the moves in the Barrow (1973) and Tavares (1976) organizers also grouped the moves for the identification of teaching strategies. The author of the dissertation and the second judge agreed that the Barrow organizer consisted of a single CE strategy. For the Tavares organizer, the author of the dissertation placed the thirty-three moves into five clusters representing two CE and three CEC strategies. The second judge identified the same basic groups, but two addition groups containing single C moves and one containing four E moves were identified. These moves occurred at the end of three of the clusters identified by the first judge. When it was emphasized that teaching strategies containing only C or E moves should not be identified unless they clearly stand alone, the second judge agreed that these moves could be included in the other three clusters.

In the second approach, the moves in the Kuhn (1967) advance organizer were marked by the author of the dissertation and the same second judge was asked to identify the teaching strategies. The twenty-five moves were placed into five clusters representing four CEC and one ECE strategy, and there was a 100% agreement between judges.

Reading Level: Reliability estimates were not obtained for the procedure used to determine reading level because there is a reliability check built into this procedure (Fry, 1968). In this procedure, the reading level is calculated from three one-hundred-word passages selected from the reading material. If there is a large variation in the data for the three passages, additional passages are analyzed to provide a wider representation of the total set of materials.

Fry (1968, p. 575) checked the validity of this procedure by comparing his results with the results for other methods for ten books representing reading levels from grades one to ten. He obtained correlation coefficients of 0.98, 0.78, 0.94 and 0.96 with SRA, Botel, Dale-Chall, and

Flesch methods respectively.

Variables with Limited Data: There were some variables for which the rater stability data was not useful because it was possible to remember the coding from the first analysis during the second analysis. These are variable 41, type of advance organizer, and variables 28 to 30 which are the variables related to the concepts in the advance organizers. Adequate estimates of inter-rater agreement were not obtained for these variables because this would have required the analysis of a large number of advance organizers by a second judge. When there was some uncertainty concerning the classification of the advance organizers as expository or comparative, the decision was made through a discussion between the author and major advisor of the dissertation.

Some inter-rater agreement data was obtained for the identification and classification of concepts and for the identification of concept attributes. Three advance organizers (Hartje, 1974; Schnell, 1973a; Toth, 1975) were used to provide this data. There was agreement between judges for the identification and classification of concepts in the Hartje and Schnell organizers. For the Toth organizer, one judge identified a correlational concept, factors affecting population growth, while the second judge identified a classificational concept, populations. For the Hartje organizer there was agreement on 84% of the nineteen concept attributes. The second judge did not identify attributes for the concept in the Schnell organizer. Since different concepts were identified for the Toth organizer there was no basis for comparison for the identification of attributes.

When the major concept for an advance organizer was difficult to identify, the decision was made through a discussion between the author and major advisor of the dissertation. The classification of all concepts was also done with the cooperation of the major advisor. Each concept was first classified by the author of the dissertation. The concept and its development in the advance organizer were then described to the major advisor and he classified it. When disagreements occurred, the concept and advance organizer were discussed until an agreement was reached. Disagreements occurred for about 10% of the concepts. The concepts identified for the advance organizers are specified in Appendix G.

In the procedures for estimating per cent agreement discussed in this section, correction factors for chance agreements were not applied. For the variables involving the identification of verbal elements and instructional strategies, it would have been difficult to estimate chance agreement because there was no established set of elements to be classified. The classification of the test questions did involve dichotomous categories so a correction could have been applied, but the per cent agreements were quite high for these variables and they would continue to be satisfactory after adjustments.

Data Analysis Procedures

The data analysis was done in three parts. Descriptive statistics, means, standard deviations and frequencies, were obtained through the use of the SPSS programs CONDESCRIPTIVE, FREQUENCIES, and CROSSTABS (Nie, et. al., 1975). The relationships between the independent and dependent variables were examined by means of individual correlation coefficients and stepwise multiple regression analysis obtained through the use of the SPSS programs PEARSON CORR and REGRESSION (Nie, et. al., 1975). The hypotheses were tested by correlation coefficients. The inter-relationships among the independent variables were examined through factor analysis performed by the SPSS program FACTOR (Nie, et. al., 1975).

CHAPTER IV

RESULTS

The results are presented in four sections. The descriptive statistics for all variables are presented in the first section. The correlation coefficients between independent and dependent variables are presented in the second section. This section also deals with the testing of the hypotheses. The third section presents the results of the regression analyses used to investigate the multivariate relationships between independent and dependent variables. The fourth section presents the results of the factor analysis used to investigate the inter-relationships among independent variables.

The various analyses mentioned above were not all done with the same data base. The main data base consisted of 99 sets of data and was used for the computation of the descriptive statistics, the computation of the correlation coefficients, and the testing of the hypotheses. A subset of these 99 cases consisting of the 77 cases for which copies of the advance organizers were available was used for the regression and factor analyses. All analyses involving variables 8, 18, and 19 which were the ability and retention variables were done using additional data sets that had been generated specifically for the examination of these variables. The raw data for each variable for each advance organizer is presented in Appendix D.

Descriptive Statistics

Means, standard deviations, and maximum and minimum values for the variables are presented in Table 5. The number of cases out of 99 having data for each variable is also specified. Table 4 contains a brief description for each variable name used to identify the variables in Table 5. The abbreviations AO and LM are used for advance organizer and learning materials respectively in these tables. More extensive definitions of the variables have been given in Chapter III. The dotted lines in Table 5 divide the variables into ten groups: dependent variables, the first three independent variables, characteristics of the sample, treatment administration conditions, subject matter, quality of the research procedures, presentation mode for the materials, reading level, kinetic structure, and teaching strategies.

The ability and retention variables (8, 18 and 19) have been omitted from the tables because the statistics for these variables were not obtained from the 99 sets of data used in the main analysis. The statistics for these

TABLE 4

VARIABLE NAMES AND DESCRIPTIONS

No.	Name	Description
1	t-statistic	Dependent variable: t-statistic for the difference between experimental and control groups.
2	Probability	Dependent variable: based on the alpha level for the t-statistic.
3	Estimated t	t-statistic was estimated from some other statistic: yes=1; no=0.
4	Covariance	Covariance used in computing dependent variables: yes=1; no=0.
5	Date	Publication data for research report.
6	Sample Size	Total number of subjects.
7	Grade Level	Grade level of subjects.
9	Prior Knowledge	Score on criterion measure in per cent prior to the experiment.
10	Achievement	Post-test score in per cent.
11	Gain Score	Achievement minus prior knowledge for the control group.
12	Number of AOs	Number of advance organizers.
13	Times for AO	Number of exposures to a given AO.
14	AO During LM	Access to the AO during the learning activities: yes=1; no=0.
15	Have AO Outside	Access to the AO outside the experimental setting: yes=1; no=0.
16	Control Intro.	Use of a control introduction: yes=1; no=0.
17	Pre-test	Use of a pre-test: yes=1; no=0.
20	AO Length-Words	No. of words in the AO.
21	AO Length-Min.	Minutes to read the AO.
22	LM Length-Words	No. of words in the LM.
23	LM Length-Min.	Minutes for learning activities.
24	AOL/LML	Length of AO divided by length of LM.
25	Science	Subject area: science=1; others=0.
26	Mathematics	Subject area: mathematics=1; others=0.
27	Other Subjects	Subject area: science or math=0; others=1.
28	Concept Type	Correlational or theoretical=1; classificational=0.
29	No. of Concepts	No. of concepts in the AO.
30	Attributes	Average no. of attributes per concept.
31	Cognitive Level	Per cent of test questions which were more than recall.

TABLE 4 (continued)

No.	Name	Description
32	Test Ans. in AO	Per cent of test questions answerable from AO information.
33	Check Alt. Hyp.	Check to see if reading AO helps to answer test: yes=1; no=0.
34	Equal Time	Time for control group on LM equal to total time for experimental group on AO and LM: yes=1; no=0.
35	Sampling	Representativeness of the sample.
36	Sample Loss	Per cent of sample lost.
37	Quality of Test	Adequacy of the validity, reliability, and objectivity of the criterion measure.
38	Wrong Unit	Use of wrong unit in analysis: yes=1; no=0.
39	Type I Error	Use of analysis procedures increasing probability of type I error: yes=1; no=0.
40	Type II Error	Use of analysis procedures increasing probability of type II error: yes=1; no=0.
41	Type of AO	Comparative=1; expository=0.
42	Mode for AO	Presentation mode for AO: reading it or listening to it being read=0; others=1.
43	Concrete Exp.-AO	Concrete experience in AO: yes=1; no=0.
44	Diagrams in AO	Diagrams in AO: yes=1; no=0.
45	Questions in AO	Review questions in AO: yes=1; no=0.
46	Mode for LM	Presentation mode for LM: reading it or listening to it being read=0; others=1.
47	Lab in LM	Laboratory work in LM: yes=1; no=0.
48	Questions in LM	Review questions in LM: yes=1; no=0.
49	Control of LM	Experimenter gave up control over learning activities: yes=1; no=0.
50	AO Reading Level	Appropriateness of reading level of AO (ratio for which 1=at grade level).
51	LM Reading Level	Appropriateness of reading level of LM (ratio for which 1=at grade level).
52	Commonality	Commonality coefficient for AO.
53	Prog. Density	Progression density coefficient for AO.

TABLE 4 (continued)

No.	Name	Description
54	No. of Moves	Number of instructional moves related to the major concepts in the AO.
55	% C Moves	Per cent of major concept moves that were C moves.
56	50% C - 50% E	Continuous variable from 0 to 50: 50 - moves were half C and half E. 0 - moves were all C or all E.
57	Moves Rpt. in LM	Per cent of the major concept moves that were repeated in the LM.
58	Subconcept Moves	Number of moves related to the subconcepts in the AO.
59	% Major Moves	Per cent of the total moves related to major concepts.
60	All C or All E	Moves are either all C or all E: yes=1; no=0.
61	% C or E	Per cent of moves in C or E strategy.
62	% CEC	Per cent of moves in CEC strategy.
63	% EC	Per cent of moves in EC strategy.
64	% CE	Per cent of moves in CE strategy.
65	% ECE	Per cent of moves in ECE strategy.

TABLE 5

DESCRIPTIVE STATISTICS

Variable		Cases	Mean	S. D.	Max.	Min.
1	t-statistic	99	0.89	1.53	7.09	-2.42
2	Probability	99	0.37	0.61	1.00	-0.93
3	Estimated t	99	0.26	0.44	1	0
4	Covariance	99	0.10	0.30	1	0
5	Date	99	71.32	3.98	77	60
6	Sample Size	99	82.83	110.08	1000	4
7	Grade Level	99	10.20	3.27	13	3
9	Prior Knowledge	27	35.48	10.44	62	20
10	Achievement	94	57.43	12.90	95	22
11	Gain Score	27	20.30	7.16	36	9
12	Number of AOs	99	1.59	1.46	9	1
13	Times for AO	90	1.20	0.71	6	1
14	AO During LM	99	0.24	0.43	1	0
15	Have AO Outside	99	0.09	0.29	1	0
16	Control Intro.	99	0.54	0.50	1	0
17	Pre-test	99	0.12	0.33	1	0
20	AO Length-Words	86	852.52	961.92	4400	26
21	AO Length-Min.	52	21.85	27.62	125	1
22	LM Length-Words	46	2402.50	2732.95	12380	67
23	LM Length-Min.	57	298.81	774.35	3850	4
24	AOL/LML	70	0.28	0.26	1.55	0.02
25	Science	99	0.55	0.50	1	0
26	Mathematics	99	0.18	0.39	1	0
27	Other Subjects	99	0.27	0.45	1	0
28	Concept Type	77	0.68	0.47	1	0
29	No. of Concepts	77	1.68	1.38	8	1
30	Attributes	77	6.23	3.66	18	1
31	Cognitive Level	49	34.14	34.25	100	0
32	Test Ans. in AO	69	6.36	18.05	100	0
33	Check Alt. Hyp.	99	0.21	0.41	1	0
34	Equal Time	99	0.19	0.40	1	0
35	Sampling	99	3.18	0.54	4	1
36	Sample Loss	85	10.01	14.65	65	0
37	Quality of Test	99	5.88	1.07	9	3
38	Wrong Unit	99	0.16	0.37	1	0
39	Type I Error	99	0.25	0.44	1	0
40	Type II Error	99	0.22	0.42	1	0

TABLE 5 (continued)

Variable	Cases	Mean	S. D.	Max.	Min.
41 Type of AO	87	0.26	0.44	1	0
42 Mode for AO	99	0.19	0.40	1	0
43 Concrete Exp.-AO	95	0.17	0.38	1	0
44 Diagrams in AO	96	0.28	0.45	1	0
45 Questions in AO	97	0.18	0.38	1	0
46 Mode for LM	99	0.53	0.50	1	0
47 Lab in LM	99	0.20	0.40	1	0
48 Questions in LM	94	0.48	0.50	1	0
49 Control of LM	99	0.20	0.40	1	0
50 AO Reading Level	72	1.02	0.29	1.73	0.37
51 LM Reading Level	43	0.99	0.35	2.06	0.41
52 Commonality	72	0.26	0.07	0.42	0.13
53 Prog. Density	72	1.94	0.75	4.00	0.70
54* No. of Moves	77	26.79	30.46	121	1
55 % C Moves	77	68.29	27.38	100	0
56 50% C - 50% E	77	22.86	18.49	50	0
57 Moves Rpt. in LM	51	25.65	31.78	100	0
58 Subconcept Moves	77	22.38	23.99	103	0
59 % Major Moves	77	54.53	22.61	100	5
60 All C or All E	77	0.26	0.44	1	0
61 % C or E	77	36.39	42.93	100	0
62 % CEC	77	30.16	35.60	100	0
63 % EC	77	13.16	29.46	100	0
64 % CE	77	14.05	28.83	100	0
65 % ECE	77	6.27	22.45	100	0

* The instructional moves identified for each advance organizer are listed in Appendix G. In this listing, the moves are grouped to identify the teaching strategies.

variables are given in the discussion of the characteristics of the sample and the treatment administration conditions. Additional information in the form of frequency counts is provided for some of the variables in the following discussion. Those variables for which the statistics in Table 5 provide an adequate description of the data have been omitted from this discussion.

Dependent Variables: The t-statistics were computed so that a positive value would mean that the observed mean for the advance organizer group was higher than that for the control group. Of the 99 t-statistics computed, 68 were positive. Nine of these were significant at the 0.05 level and thirteen were significant at the 0.01 level. None of the 29 negative t-statistics were significant. If the results of the advance organizer research were due only to chance, one would have expected an equal number of positive and negative t-statistics. Therefore, the above results indicate that there is a tendency for advance organizers to show facilitative effects.

Characteristics of the Sample: The grade level variable is not discussed at this point because a cross tabulation of subject area by grade is given in the discussion of the subject matter variables.

6. Sample Size: Although the largest sample size was 1000, the second largest was only 322 and there were only 19 cases for which the sample size was larger than 100.

Most of the small sample sizes were for cases in which class was used as the unit of analysis.

8. Learning Ability: There were 32 experiments in which ability level was used as a blocking variable. A data set was generated for each ability level in each experiment resulting in 77 data sets. Learning ability was specified by scale values from 1 to 5 for which 5 was high. The mean and standard deviation for ability level for the 77 cases were 3.05 and 1.52 respectively.

Treatment Administration Conditions:

12. Number of Advance Organizers: There were only 20 cases for which more than one advance organizer was used.

13. Times to Read AO: There were only ten cases for which the subjects were exposed to a given advance organizer on more than one occasion. This variable was not coded for those cases in which subjects were allowed to have the advance organizers outside of the experimental setting.

18. Retention Test: There were 33 experiments in which retention tests were given. A total of 36 retention measures were reported.

19. Retention Time: The longest time between achievement and retention tests was 180 days, but this was specified as 99 for the data analysis because only two columns had been allowed for this variable on the data cards. The second longest retention time was 63 days. The shortest retention time was seven days. The mean and standard

deviation were 20.8 and 20.0 respectively.

24. AO Length/LM Length: There were two cases for which the advance organizer was longer than the learning materials. In 90% of the cases, the advance organizer was less than half as long as the learning materials.

Subject Matter: A cross tabulation for subject area by grade is presented in Table 6. The totals for each subject area and grade category are also given. All post-secondary students were coded as grade 13.

TABLE 6

SUBJECT BY GRADE CROSS TABULATION

	Grade Level				
Subject	3-6	7-9	10-12	13	Total
Science	14	11	8	21	54
Math	1	2	2	13	18
Other	3	7	2	15	27
Total	18	20	12	49	99

Almost half of the advance organizer research has been done at the post-secondary level and more than half of it has used science content. The distribution across grade levels is not constant for the three subject areas. Most of the studies done at the elementary level have used science content. Most of the studies using mathematics content have been done at the post-secondary level. These trends are supported by significant correlation coefficients between grade level and the dichotomous variables identifying science and mathematics content.

29. Number of Concepts: In 71% of the cases, only one major concept was identified for the advance organizer.

31. Cognitive Level of the Test: In 37% of the cases, the test consisted of all recall questions. In 6% of the cases, the test consisted of all higher level questions.

Quality of the Research Procedures:

32. Per Cent of Test Answerable by AO: For 72% of the cases, none of the test questions were considered to be answerable from the advance organizer information. There were only two cases for which more than 50% of the test questions were considered to be answerable from the advance organizer information.

35. Representativeness of the Sample: The use of a convenient intact group was the most common sampling procedure and it was used in 71% of the cases. Random sampling from a larger population was used in 24% of the cases.

36. Loss of Sample: There was no sample loss in 51% of the cases.

Presentation Mode: The frequencies for the use of the various presentation modes for the advance organizer and learning materials are given in Table 7. For the data analysis, dichotomous variables were used for which reading was one category and all the other modes made up the other category. Students listening to someone read materials was included in the reading category.

TABLE 7

PRESENTATION MODE FOR MATERIALS

Presentation Mode	Advance Organizer	Learning Materials
Reading	80	47
Audiovisual	5	7
Classroom Instruction	8	17
Programmed Instruction	3	17
Laboratory Work	3	11

Reading Level: The reading level of the advance organizer was higher than the grade level of the subjects for 39% of the cases. For the learning materials, this was true for 47% of the cases.

Kinetic Structure: A fairly representative range of values was obtained for both the commonality and progression density coefficients. The mean value of 0.26 for the commonality coefficient is probably somewhat lower than might have been expected from the range of values identified in the literature review in Chapter II (O. R. Anderson, 1971;

Huegel, 1975; Muehlke, 1973). These sources gave average values in the area of 0.30 to 0.35 for classroom materials. Expected values for the progression density coefficient were not identified in the literature sources.

Teaching Strategies: In the following discussion, characterization moves and exemplification moves are specified by C and E respectively. There were eighteen advance organizers for which only C moves were identified, and there were two advance organizers for which only E moves were identified. Since the teaching strategy consisting of only E moves was used so infrequently, this was not maintained as a separate variable. A single teaching strategy called a pure strategy was defined as a sequence of moves containing only C moves or only E moves.

The strategies that were most frequently identified in the advance organizers were the pure strategy and the CEC strategy. These were identified in almost half of the advance organizers. The CE and EC strategies were identified in about 25% of the advance organizers. The ECE strategy was the least frequently used being identified in only 13% of the advance organizers.

Correlations Between Independent and Dependent Variables

This section deals with the relationships of each independent variable with the dependent variables. Since the hypotheses involved the prediction of relationships between selected independent variables and the dependent variables, they are also discussed in this section.

The correlations of the independent variables with both dependent variables were examined to determine the extent to which the observed relationships varied according to the selection of the dependent variable. The correlation between the two dependent variables was 0.88.

The coefficients for the correlation between each independent variable and the two dependent variables are presented in Table 8. The significance level for each coefficient, and the number of cases on which each coefficient is based are also given. A two-tailed test of significance was applied for most of the variables, but some directional relationships, as identified in the hypotheses in Chapters I and III, were predicted prior to the data analysis so a one-tailed test was used for the variables to which the hypotheses relate. The significance levels for these variables are marked by asterisks in Table 8. The variable names in Table 8 correspond to those used in Table 4 which contains brief descriptions of the variables.

The dotted lines in Table 8 divide the independent variables into nine groups: variables 3-5, characteristics of the sample, treatment administration conditions, subject matter, quality of the research procedures, presentation mode for the materials, reading level, kinetic structure,

TABLE 8

CORRELATIONS OF INDEPENDENT VARIABLES WITH DEPENDENT VARIABLES

			Dependent Variables			
			t-statistic		Probability	
	Independent Variable	Cases	r	sig.	r	sig.
3	Estimated t	99	0.01	0.952	0.03	0.786
4	Covariance	99	0.06	0.572	0.03	0.786
5	Date	99	-0.14	0.172	-0.19	0.064
6	Sample Size	99	-0.03	0.739	0.01	0.919
7	Grade Level	99	0.24	0.008*	0.23	0.011*
9	Prior Knowledge	27	-0.21	0.297	-0.17	0.397
10	Achievement	94	-0.01	0.923	0.02	0.880
11	Gain Score	27	0.40	0.019*	0.38	0.024*
12	Number of AOs	99	-0.10	0.322	-0.22	0.031
13	Times for AO	90	0.10	0.330	0.00	0.969
14	AO During LM	99	-0.29	0.003	-0.31	0.002
15	Have AO Outside	99	-0.13	0.189	-0.18	0.074
16	Control Intro.	99	0.05	0.614	0.06	0.556
17	Pre-test	99	0.03	0.750	0.07	0.508
20	AO Length-Words	86	-0.10	0.355	-0.13	0.246
21	AO Length-Min.	52	0.23	0.106	0.28	0.046
22	LM Length-Words	46	0.03	0.865	0.00	0.980
23	LM Length-Min.	57	-0.19	0.152	-0.31	0.020
24	AOL/LML	70	-0.07	0.585	0.01	0.967
25	Science	99	-0.24	0.019	-0.32	0.001
26	Mathematics	99	-0.05	0.647	0.07	0.512
27	Other Subjects	99	0.30	0.002	0.30	0.003
28	Concept Type	77	-0.19	0.104	-0.28	0.013
29	No. of Concepts	77	-0.25	0.030	-0.28	0.015
30	Attributes	77	0.09	0.451	0.00	0.988
31	Cognitive Level	49	0.12	0.427	0.19	0.197
32	Test Ans. in AO	69	0.25	0.037	0.18	0.144
33	Check Alt. Hyp.	99	0.05	0.658	-0.01	0.944
34	Equal Time	99	-0.23	0.022	-0.23	0.023
35	Sampling	99	-0.05	0.598	-0.04	0.664
36	Sample Loss	85	-0.10	0.345	-0.06	0.577
37	Quality of Test	99	-0.08	0.442	-0.05	0.626

TABLE 8 (continued)

		Dependent Variables			
		t-statistic		Probability	
Independent Variables	Cases	r	sig.	r	sig.
38 Wrong Unit	99	-0.06	0.576	-0.15	0.133
39 Type I Error	99	0.07	0.493	0.09	0.391
40 Type II Error	99	-0.07	0.481	-0.09	0.392
41 Type of AO	87	0.31	0.003	0.31	0.004
42 Mode for AO	99	0.25	0.013	0.27	0.008
43 Concrete Exp.-A0	95	0.11	0.262	0.09	0.381
44 Diagrams in AO	96	0.16	0.128	0.09	0.368
45 Questions in AO	97	-0.01	0.946	0.05	0.650
46 Mode for LM	99	0.03	0.769	-0.02	0.836
47 Lab in LM	99	0.03	0.739	-0.05	0.630
48 Questions in LM	94	-0.06	0.627	-0.07	0.494
49 Control of LM	99	-0.13	0.205	-0.17	0.101
50 AO Reading Level	72	0.13	0.114*	0.26	0.014*
51 LM Reading Level	43	0.11	0.493	0.22	0.165
52 Commonality	72	-0.04	0.725	0.01	0.941
53 Prog. Density	72	-0.23	0.028*	-0.23	0.025*
54 No. of Moves	77	-0.06	0.591	-0.10	0.373
55 % C Moves	77	-0.04	0.752	-0.04	0.750
56 50% C - 50% E	77	0.06	0.597	-0.02	0.866
57 Moves Rpt. in LM	51	-0.16	0.130*	-0.14	0.160*
58 Subconcept Moves	77	-0.04	0.722	-0.08	0.495
59 % Major Moves	77	0.03	0.810	0.02	0.876
60 All C or All E	77	-0.11	0.177*	-0.04	0.377*
61 % C or E	77	-0.16	0.076*	-0.11	0.169*
62 % CEC	77	0.25	0.029	0.13	0.274
63 % EC	77	-0.11	0.329	-0.08	0.480
64 % CE	77	-0.06	0.578	-0.06	0.592
65 % ECE	77	0.15	0.186	0.20	0.084

* significance level for a one-tailed test.

Note: The correlation between the dependent variables was 0.88.

and teaching strategies. The variables are also grouped into these nine categories in the following discussion. The ability and retention variables (8, 18 and 19) have been omitted from Table 8 because the coefficients for these variables were not computed from the 99 data sets used in the computation of the coefficients for the other variables. The coefficients for these variables are given below in the discussion of the characteristics of the sample and the treatment administration conditions.

Each hypothesis is discussed along with the independent variable to which it relates. The following list identifies the independent variables for which relationships were predicted in the hypotheses:

hypothesis 1 - variable 7.
hypothesis 2 - variable 8.
hypothesis 3 - variable 11.
hypothesis 4 - variable 50.
hypothesis 5 - variable 52.
hypothesis 6 - variable 53.
hypothesis 7 - variables 60 and 61.
hypothesis 8 - variable 57.

The results pertaining to the eight hypotheses are summarized at the end of this section.

Variables 3 and 4: The near zero coefficients for these variables indicate that the procedures used to estimate the t-statistic when it could not be computed directly did not create a consistent bias in the results.

Characteristics of the Sample: The variables in this category having significant correlations with the dependent variables are grade level and gain score.

6. Sample Size: Sample size did not have a significant correlation with either dependent variable. The lack of correlation with the probability variable is particularly interesting. This indicates that sample size was not a major factor in determining whether or not significant differences were obtained in an experiment. When the probability variable was converted to an absolute value, the correlation with sample size did not change an appreciable amount.

7. Grade Level: Hypothesis 1 predicted a positive correlation between grade level and the dependent variables. The coefficients for the correlation of grade with t-statistic and probability were 0.24 and 0.23 respectively. Both coefficients are significant at the 0.01 level for a one-tailed test. There was a greater tendency for the advance organizers to show facilitative effects as the grade level of the subjects increased.

The prediction of this relationship was made on the basis of a preliminary scan of the advance organizer research reports which indicated that the treatments commonly involved a fairly brief exposure to an advance organizer containing a fairly high concentration of information. It was postulated that students in the lower grade levels may have had some difficulty understanding the information presented in these materials.

An alternate explanation for this relationship is the possibility that the process of meaningful learning involving the incorporation of new material through its relationship to subsumers in cognitive structure does not apply to young children. However, Ryder (1970) obtained a significant facilitative effect for an advance organizer with grade three students. Lawton (1977) demonstrated that elementary students gained more from exposure to an advance organizer when it included instruction concerning strategies for processing the advance organizer information.

The possible interactive effects of grade level with other independent variables are discussed later in this chapter in the section on the inter-relationships among independent variables.

8. Learning Ability: Hypothesis 2 predicted a positive correlation between the learning ability of the subjects and the dependent variables. The coefficients for ability were calculated from 77 sets of data that were generated from 32 experiments in which ability had been used as a blocking variable. The coefficients for the correlation of ability with t-statistic and probability were -0.06 and -0.01 respectively.

One possible reason why the predicted relationship was not observed is that a variety of criteria such as IQ, basic skills, and reading ability were used to identify the ability levels in the various experiments. A second factor is that the separation between high and low ability levels was not consistent across experiments. For example, the lower third of a group of university students will probably have a higher average IQ than will the lower third of a group of elementary school students. A third consideration is the possibility that there may be two opposing factors influencing the interaction of ability level with the facilitative effects of advance organizers. Ausubel and Fitzgerald (1962, p. 270) feel that it is the low ability student who is more likely to require an advance organizer. However, it is also the low ability student who is more likely to have difficulty in understanding the advance organizer information.

In order to investigate the effect of ability in more detail a variable to measure the extent of the treatment by ability interaction was computed for each experiment in which ability was used as a blocking variable. This variable was (HAO-HC)-(LAO-LC) divided by the standard deviation for the combined group. The abbreviations represent the means for the high advance organizer, high control, low advance organizer and low control groups respectively. The relationships discussed below were identified from the significant correlations between this variable and the independent variables.

There was a greater tendency for advance organizers to be more beneficial for the high ability group than for the low ability group under the following conditions:

- as the percentage of higher level questions in the achievement test increased.
- as the length of the advance organizer increased.
- when the subject area was mathematics.
- when the reading level of the advance organizer was more appropriate to the grade level.
- when the presentation mode for the advance organizer and learning materials was other than reading.
- when the advance organizer contained diagrams.
- when the advance organizer and learning materials contained review questions.

There was a greater tendency for advance organizers to be more beneficial for the low ability group when the subject matter was other than science or mathematics.

11. Gain Score: Hypothesis 3 predicted a significant correlation between gain score and the dependent variables. The coefficients for the correlation of gain score with t-statistic and probability were 0.40 and 0.38 respectively. Both coefficients are significant at the 0.025 level for a one-tailed test. These correlations indicate that there was a greater tendency for the advance organizers to show facilitative effects as the gain score for the control group increased. The advance organizer group was not included in the computation of the gain score because the gain score was intended to be an indication of how much was learned from

the learning materials alone.

One explanation for this relationship is the possibility that the amount learned from the learning materials is an indication of the learning difficulty of the advance organizer. Advance organizers which students were not able to understand would have been less likely to show facilitative effects. A second explanation is that low gain scores could possibly mean that the test was not a valid measure of learning from the materials in which case actual differences between treatment groups would not have been detected. A third consideration is that the level of understanding prior to the experiment may have been too high to allow for much gain. The correlation between prior knowledge and gain score was -0.20 which is not statistically significant so this was not a major factor.

Treatment Administration Conditions: The variables in this category which had significant correlations with the dependent variables were the number of advance organizers, access to the advance organizer during learning activities, and the length of the treatment. All of these variables were related to a number of the other independent variables and these relationships are discussed later in this chapter in the section on the inter-relationships among the independent variables.

12. Number of Advance Organizers: There was a significant negative correlation between variable 12 and

probability indicating that the tendency for the advance organizers to show facilitative effects decreased as the number of advance organizers placed within the learning materials increased. The correlation of variable 12 with t-statistic was also negative but not significant. This is probably not simply a length effect because the amount of time spent on the advance organizer had a positive correlation with probability.

14. AO During LM: Variable 14 had significant negative correlations with both dependent variables indicating that the advance organizers had a lesser tendency to show facilitative effects for those cases in which the subjects had access to the advance organizers while they worked on the learning materials. A possible explanation for this relationship is that a clear distinction was not made between the advance organizers and learning materials in many of these cases and in some cases the advance organizers were simply given to the students as assigned reading with no check to see whether or not the students did read them.

18. Retention Test: The correlation coefficients for variable 18 were computed from 69 sets of data consisting of the 33 cases for immediate achievement for experiments in which retention measures were given plus the 36 cases generated for the retention measures in these 33 experiments. The coefficients for the correlation of variable 18 with t-statistic and probability were -0.04 and -0.08

respectively. Neither coefficient is significant.

19. Retention Time: The correlation coefficients for variable 19 were computed from the 36 cases generated for the retention measures. The coefficients for the correlation of retention time with t-statistic and probability were 0.07 and 0.12 respectively. Neither coefficient is significant.

21. Length of the AO in Minutes: There was a significant positive correlation between variable 21 and probability indicating that there was a greater tendency for the advance organizers to show facilitative effects as the amount of time spent on the advance organizers increased. The correlation of variable 21 with t-statistic was also positive but not significant. The correlation coefficients between variable 20, the length of the advance organizer in words, and the dependent variables were not significant but they were negative. The correlation between variables 20 and 21 was 0.71. It appears that the amount of time spent on the advance organizers had a greater influence on their effectiveness than did the quantity of material presented in them.

Because of the difference in the relationships of these two variables with the dependent variables, a third variable was generated to measure the rate at which students were required to process the advance organizer information (words per minute). This new variable was variable 20 divided by variable 21. The coefficients for the correlation of words per minute with t-statistic and probability were -0.21 and -0.24 respectively. These coefficients were based on 43 cases and the significance levels associated with them are 0.18 and 0.12 respectively. The results for these three variables tend to indicate that there was a greater tendency for the advance organizers to show facilitative effects as the students were allowed more time to process the advance organizer information.

23. Length of LM in Minutes: There was a significant negative correlation between variable 23 and probability indicating that there was a lesser tendency for the advance organizers to show facilitative effects as the amount of time spent on the learning activities increased. The correlation of variable 23 with t-statistic was also negative but not significant. This negative correlation could possibly be a result of the relationship of variable 23 with other variables having negative correlations with the dependent variables. The coefficients for the correlation of variable 23 with variables 12 and 14 are 0.44 and 0.53 respectively. Variables 12 and 14 were discussed earlier in this section.

Subject Matter: The variables in this group having significant correlations with the dependent variables are science, other subjects, concept type, and number of concepts. The relationships of these variables to the other independent variables are discussed later in this chapter in the section on the inter-relationships among the independent variables.

25. Science: Variable 25 had significant negative correlations with both dependent variables indicating that there was a lesser tendency for the advance organizers to show facilitative effects when the subject matter was science.

27. Other Subjects: Variable 27 had significant positive correlations with both dependent variables indicating that there was a greater tendency for the advance organizers to show facilitative effects when the subject matter was other than science or mathematics.

28. Concept Type: There was a significant negative correlation between concept type and probability indicating that there was a greater tendency for the advance organizers to show facilitative effects when the main concepts in the advance organizers were classificational. The correlation of concept type with t-statistic is also negative but not significant.

29. Number of Concepts: Variable 29 had significant negative correlations with both dependent variables indicating that there was a lesser tendency for the advance organizers to show facilitative effects as the number of concepts presented in the advance organizers increased. Since the function of the advance organizer is to generate a

subsumer in cognitive structure for the information in the learning materials, a general concept should be clearly identified as its main focus.

Quality of the Research Procedures: Two of the variables pertaining to internal validity had significant correlations with the dependent variables. None of the variables pertaining to external validity had significant correlations with the dependent variables. Since the dependent variables were computed from raw data whenever possible, some of the potential for relationships between the external validity variables and the dependent variables was removed.

32. Per Cent of Test Answerable by AO: There was a significant positive correlation between variable 32 and t-statistic indicating that there was a greater tendency for the advance organizers to show facilitative effects as the percentage of test questions judged to be answerable by the advance organizer information increased.

34. Time Equalization: Variable 34 had significant negative correlations with both dependent variables indicating that there was a lesser tendency for the advance organizers to show facilitative effects when the control group studied the learning materials for a period of time equal to the combined time that the experimental group studied the advance organizer and learning materials.

The relationship of variables 32 and 34 with the dependent variables indicates that there were some factors contributing to the facilitative effects of advance organizers other than the role of subsumers in meaningful reception learning.

Characteristics of the Materials: The variables in this group having significant correlations with the dependent variables are type of advance organizer, presentation mode for the advance organizer, appropriateness of the reading level of the advance organizer, progression density, and the CEC teaching strategy.

41. Type of Advance Organizer: Variable 41 had significant positive correlations with both dependent variables indicating that comparative advance organizers had a greater tendency to show facilitative effects than did expository advance organizers. A possible explanation for this relationship is that comparative advance organizers tend to utilize existing concepts in cognitive structure to a greater extent than do expository organizers.

Presentation Mode: Only the presentation mode for the advance organizer had significant correlations with the dependent variables. In Table 7 in the preceding section on the descriptive statistics, the category specified as other than reading was further broken down into four categories: audio-visual aids, classroom instruction, programmed instruction, and laboratory work. The number of cases using each of these modes for the advance organizers was too small to allow separate analyses for each mode. For the learning materials, four additional dichotomous variables were created for the four modes. None of these modes had significant relationships with the dependent variables.

42. Presentation Mode for the AO: Variable 42 had significant positive correlations with both dependent variables indicating that there was a greater tendency for the advance organizers to show facilitative effects when the presentation mode was other than reading. It is possible that students developed a better understanding of the advance organizer information under these other presentation modes.

Reading Level:

50. Appropriateness of the Reading Level of the AO: Hypothesis 4 predicted positive correlations between variable 50 and the dependent variables. The coefficients for the correlation of variable 50 with t-statistic and probability were 0.13 and 0.26 respectively. The correlation with probability is significant at the 0.01 level for a one-tailed test. This correlation indicates that advance organizers that were written at a reading level appropriate to the grade level of the subjects had a greater tendency to show facilitative effects. Students probably had more difficulty understanding the advance organizer information when the reading level was higher than their grade level.

Kinetic Structure: Progression density had significant correlations with the dependent variables but commonality did not. Anderson[1] feels that progression density is the more important variable to be considered in the construction of advance organizers. If the introduction of new material is too rapid, students may have difficulty in forming the generalizations required for establishing the subsumer.

52. Commonality Coefficient: Hypothesis 5 predicted positive correlations between variable 52 and the dependent variables. The coefficients for the correlation of commonality with t-statistic and probability were not significant.

53. Progression Density Coefficient: Hypothesis 6 predicted negative correlations between variable 53 and the dependent variables. The coefficients for the correlation of progression density with t-statistic and probability were both -0.23 which is significant at the 0.025 level for a one-tailed test. These correlations indicate that there was a lesser tendency for advance organizers to show facilitative effects as the rate of introduction of new material increased. Even small correlations of this variable with the dependent variables are important because progression density was only one of several factors influencing the

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[1] Personal communication with O. R. Anderson at Teachers College, Columbia University, New York.

understandability of the advance organizers and understandability was only one of several factors influencing the effectiveness of the advance organizers.

Teaching Strategies: The only variable in this category which had a significant correlation with a dependent variable is the teaching strategy utilizing the sequence characterization, exemplification, characterization--CEC.

57. Per Cent Moves Repeated in LM: Hypothesis 8 predicted negative correlations between variable 57 and the dependent variables. The coefficients for the correlation of variable 57 with t-statistic and probability were both negative but not significant using a one-tailed test. It is possible that placing the advance organizer information within the learning materials is not equivalent to the presentation of an advance organizer. Ausubel (1970, p. 3) feels that advance organizers should be more effective than intra-material organizational devices.

Variables 60 and 61: Both of these variables are measures of the extent to which the advance organizers utilized a pure strategy consisting of only characterization moves or only exemplification moves. Hypothesis 7 predicted negative correlations between these variables and the dependent variables. The correlation of these variables with t-statistic and probability were all negative but none were significant using a one-tailed test.

Of the 77 cases for which teaching strategy data was available, there were 14 cases in which the advance organizers showed significant facilitative effects. Only one of the twenty advance organizers utilizing a completely pure teaching strategy showed a significant facilitative effect. While the correlations for variables 60 and 61 with the dependent variables were not significant, there was a fairly strong trend in the predicted direction.

62. Per Cent of Moves in CEC Strategy: There was a significant correlation between variable 62 and t-statistic indicating that advance organizers utilizing a CEC teaching strategy had a greater tendency to show facilitative effects. This teaching strategy, the statement of a generalization followed by examples followed by a restatement of the generalization, has a great deal of intuitive appeal for the construction of advance organizers because the purpose of advance organizers is to establish broad concepts within cognitive structure.

Summary: There were no major differences between the results for t-statistic and the results for probability. Ten independent variables had significant correlations with both dependent variables. Five independent variables had significant correlations with probability but not with t-statistic, and two had significant correlations with t-statistic, but not with probability. When a given variable had a significant correlation with only one of the dependent variables, the non-significant correlation was of the same sign as the significant one.

Four of the eight predicted relationships in the hypotheses were supported by significant correlations between independent and dependent variables. The four that were supported were those relating to grade level, gain score, reading level, and progression density.

The other independent variables which had significant correlations with the dependent variables were four treatment administration condition variables, four subject matter variables, two variables related to the internal validity of the experiments, the type of advance organizer, the presentation mode for the advance organizer, and the CEC teaching strategy.

Regression Analysis

The multivariate relationship of the independent variables with the dependent variables was examined by regression analysis. This analysis was done to determine what portion of the variance in the dependent variables was predictable from the independent variables and to identify those independent variables which made the greatest contribution to this prediction.

The regression analysis was done using only the data sets for those 77 cases for which copies of the advance organizers were available. Since the data for a large number of variables were obtained from the advance organizers, the 22 data sets omitted from the analysis had large amounts of missing data. Some variables still had a considerable amount of missing data even after the data base was reduced to 77 cases. The ten variables which had missing data for more than 10% of the 77 cases were omitted from the analysis. Four variables were omitted from the analysis because they had very skewed distributions. For these variables, more than 65 out of the 77 cases had a given value. Another eight variables were omitted for various reasons. The dependent variables and the 41 independent variables included in the regression analysis are listed in Table 9 along with the means and standard deviations computed from the 77 cases. The number of cases having data for each variable is also given. The variable names and numbers in Table 9 correspond to those used in Table 4 which was presented earlier in this chapter and contains brief descriptions of the variables. The correlation matrix for these variables is given in Appendix E. The correlations between dependent and independent variables remained fairly constant when the data base was reduced from 99 to 77 cases.

Separate analyses were done for each dependent variable so that the results for the two variables could be compared. A stepwise procedure was employed in the analyses. Variables 32 and 34 were forced at the first step to remove that portion of the variance in the dependent variables that was

TABLE 9

VARIABLES IN THE REGRESSION ANALYSIS

Variable		Cases	Mean	S. D.
1	t-statistic	77	0.78	1.54
2	Probability	77	0.32	0.62
5	Date	77	71.57	3.64
7	Grade Level	77	10.18	3.27
10	Achievement	74	57.42	12.40
12	Number of AOs	77	1.62	1.44
14	AO During LM	77	0.29	0.45
16	Control Intro.	77	0.47	0.50
20	AO Length-Words	75	908.23	1016.65
25	Science	77	0.55	0.50
26	Mathematics	77	0.21	0.41
27	Other Subjects	77	0.25	0.43
28	Concept Type	77	0.68	0.47
29	No. of Concepts	77	1.68	1.38
30	Attributes	77	6.21	3.68
32	Test Ans. in AO	69	6.36	18.05
33	Check Alt. Hyp.	77	0.27	0.45
34	Equal Time	77	0.25	0.43
35	Sampling	77	3.22	0.60
37	Quality of Test	77	5.81	1.01
38	Wrong Unit	77	0.19	0.40
39	Type I Error	77	0.25	0.43
40	Type II Error	77	0.19	0.40
41	Type of AO	77	0.23	0.43
42	Mode for AO	77	0.14	0.35
43	Concrete Exp.-AO	77	0.16	0.37
44	Diagrams in AO	77	0.31	0.47
45	Questions in AO	77	0.18	0.39
46	Mode for LM	77	0.53	0.50
47	Lab in LM	77	0.23	0.43
48	Questions in LM	72	0.50	0.50
49	Control of LM	77	0.25	0.43
50	AO Reading Level	72	1.02	0.29
52	Commonality	72	0.26	0.07
53	Prog. Density	72	1.94	0.75
54	No. of Moves	77	26.79	30.46
56	50% C - 50% E	77	22.86	18.49
58	Subconcept Moves	77	22.38	23.99
60	All C or All E	77	0.26	0.44
61	% C or E	77	36.39	42.93
62	% CEC	77	30.16	35.60
63	% EC	77	13.16	29.46
64	% CE	77	14.05	28.83

due to the alternative explanations for the facilitative effects of advance organizers represented by these variables. These alternative explanations are that the facilitative effects could have been due to the direct contribution of the advance organizer alone to answering the test questions or to a study time factor.

At each successive step in the analysis, the remaining independent variables were free to enter the regression equation according to the magnitude of their partial correlations with the dependent variable. The analysis was continued for ten steps and the results for each step were inspected to determine the point at which additional variables no longer made significant contributions to the multiple correlation. The decision of when to terminate the analysis was made on the basis of the increase in the squared multiple correlation and the significance level of the beta coefficient for the new variable entered at each step. A reasonable cut-off point appeared to be when the increase in the squared multiple correlation fell below 0.04.

The results for the regression analyses for the dependent variables, t-statistic and probability, are presented in Tables 10 and 11 respectively. The variables are listed along with the multiple correlations and squared multiple correlations in the order that they entered the stepwise analyses. The standardized beta weights are given for the

TABLE 10

REGRESSION ANALYSIS FOR t-STATISTIC

Variable	Mult. R	R^2	Beta	F(1,58)	Sig.
34 Equal Time	0.22	0.05	-0.27	5.87	0.019
32 Test Ans. in AO	0.36	0.13	0.20	3.05	0.086
41 Type of AO	0.46	0.21	0.29	7.02	0.010
62 % CEC	0.52	0.27	0.25	4.65	0.035
42 Mode for AO	0.56	0.31	0.20	3.46	0.068

TABLE 11

REGRESSION ANALYSIS FOR PROBABILITY

Variable	Mult. R	R^2	Beta	F(1,58)	Sig.
34 Equal Time	0.22	0.05	-0.11	0.75	0.390
32 Test Ans. in AO	0.30	0.09	0.15	1.66	0.203
25 Science	0.41	0.17	-0.27	5.53	0.022
12 Number of AOs	0.50	0.25	-0.31	6.44	0.014
42 Mode for AO	0.54	0.30	0.22	3.92	0.052

regression equations involving the five variables in each table. The F-ratios and significance levels for each beta weight are also given.

The analysis for both dependent variables was stopped at five variables and these variables accounted for approximately 30% of the variance in both analyses. Variables 32 and 34 accounted for approximately 10% of the variance. For both of these analyses, the multiple correlations at the fifth step were significant at the 0.001 level.

Other than the two variables that were forced, variable 42 which is the presentation mode for the advance organizer was the only variable appearing in the regression equations for both dependent variables. The other two variables in the regression equation for t-statistic were the type of advance organizer and the CEC teaching strategy. The only negative beta weight in this regression equation was for variable 34. The other two variables in the regression equation for probability were the science subject area and the number of advance organizers. These two variables and variable 34 all had negative beta weights for this regression equation.

When the regression analysis was performed without forcing variables 32 and 34, these variables did not enter the regression equations within the first ten steps. The order of the other variables in the regression equation for probability was unchanged. The first two variables in the regression equation for t-statistic were unchanged, but other subjects, number of advance organizers, and questions in the learning materials all preceded variable 42. Removing the effect of variables 32 and 34 did not have a major effect on the relationships between the independent and dependent variables.

Since there was not a very wide spread among the significant correlations between independent and dependent variables, small shifts in those correlations would probably give different regression equations. Therefore the specific variables identified in these regression equations would probably not be reproduced in a second analysis. The per cent of variance accounted for by the squared multiple correlations in these analyses is possibly an underestimate because some variables having fairly high correlations with the dependent variables were omitted from the regression analysis because of missing data. These include the gain score and the lengths of the advance organizer and learning materials in minutes.

Inter-relationships Among Independent Variables

A factor analysis using squared multiple correlations as estimates of the communalities was used to examine the inter-relationships among the independent variables. The results of the factor analysis were used to help interpret the relationships between independent and dependent variables that were discussed in the two preceding sections.

The factor analysis was done with the same 77 data sets that were used in the regression analysis. The variables entered into the factor analysis were the same ones that were used in the regression analysis with the exception of the dependent variables and variable 26 which is the mathematics subject area. One of the subject area variables had to be removed because the third subject area variable is completely determined from the other two. Mathematics was removed because it had the lowest correlation with the dependent variables. These variables were listed with means and standard deviations in Table 9 in the preceding section.

A six-factor solution was obtained and an oblique rotation was applied using the direct oblimin criterion with the delta value set at zero which tends to give a fairly oblique solution (Nie, et. al., 1975, p. 485). The degree of obliqueness is reflected in the correlations among the six factors presented in Table 12. The largest correlation between any two factors was -0.16.

The decision to retain six factors was based on an inspection of solutions having five, six, seven, and eight factors. The main decision was between six and seven factors. The six factors were readily interpretable and most of the variables were represented. When seven factors were retained, the additional factor appeared to be a quality of the research factor which was not represented in the six-factor solution. However, the addition of the seventh factor caused a number of variables to split across two or more factors so the solution with six factors was retained. The eigen values, per cent of variance accounted for, and the factor pattern matrix for the six factors along with the communalities for each variable are presented in Appendix F.

TABLE 12

FACTOR CORRELATION MATRIX

Factor	I	II	III	IV	V	VI
I	1.00					
II	-0.02	1.00				
III	0.11	-0.01	1.00			
IV	0.10	-0.04	0.05	1.00		
V	0.12	0.05	-0.02	0.04	1.00	
VI	-0.16	0.05	0.04	-0.14	0.03	1.00

The variables having loadings of 0.30 and higher are listed for each factor in Tables 13-18. The coefficients for the correlation of each independent variable and factor with the dependent variables are included. There were five independent variables which did not load on any of the six factors. These were variables 37, 39, 40 and 41 which are in the category of quality of the research procedures, and variable 64 which is the CE teaching strategy. In the following discussion of the factors, the relationships of the independent variables in each factor with the dependent variables are also discussed.

Factor I - Length: Most of the variables in this factor are clearly related to the length of the advance organizer. The correlations of this factor with the dependent variables are quite low. Variable 20, which is the most direct measure of length being the number of words in the advance organizer, also has low correlations with the dependent variables. The correlations of variables 12 and 29 with the dependent variables are undoubtedly due to some factor other than length, because of their relatively low loadings on this factor. These variables may have some other common factor such as complexity. It is possible that the advance organizers had a lesser tendency to show facilitative effects as the experimental materials became more complex.

Factor II - Administration Conditions: The variables with high loadings on this factor are mainly conditions which were manipulated by the researcher. The loading of grade level on this factor may indicate that certain kinds of experimental procedures were more common at one level than at another. Many of these variables and the factor itself have significant correlations with the dependent variables.

TABLE 13

FACTOR I - LENGTH

Independent Variable		Loading	Correlations Dep. Var. #1 t-statistic	 Dep. Var. #2 Probability
12	Number of AOs	0.51	-0.27	-0.32
20	Length-Words	0.95	-0.08	-0.12
29	No. of Concepts	0.65	-0.25	-0.28
30	Attributes	0.48	0.09	0.00
34	Equal Time	0.32	-0.22	-0.22
49	Control of LM	0.38	-0.11	-0.17
54	No. of Moves	0.92	-0.06	-0.10
58	Subconcept Moves	0.86	-0.04	-0.08
63	% EC	-0.30	-0.11	-0.08
Factor I			0.13	-0.01

TABLE 14

FACTOR II - ADMINISTRATION CONDITIONS

Independent Variable		Loading	Correlations Dep. Var. #1 t-statistic	 Dep. Var. #2 Probability
5	Date	0.39	-0.20	-0.23
7	Grade Level	-0.46	0.26	0.26
12	Number of AOs	0.47	-0.27	-0.32
14	AO During LM	0.57	-0.28	-0.30
16	Control Intro.	-0.62	0.04	0.01
34	Equal Time	0.56	-0.22	-0.22
35	Sampling	0.58	-0.05	-0.04
50	AO Reading Level	-0.32	0.13	0.26
Factor II			-0.22	-0.29

Factor III - Subject: This is clearly a subject matter factor and the signs of the loadings indicate that it is a science factor. The positive loadings for the laboratory and concrete experience variables lend support to calling it a science factor. The correlations of this factor with the dependent variables was negative. The independent variables having significant correlations with the dependent variables were science, other subjects, and concept type. The correlation between variables 25 and 28 was 0.54 indicating that the advance organizers with the science content presented fewer classificational concepts so it is difficult to determine whether the correlation with the dependent variables was due mainly to subject area or to concept type. This is further confounded by the relationship of science subject matter with grade level which was not revealed in the factor solution. The studies that were done at the lower grade levels tended to use science content more often than other subject areas.

Factor IV - Presentation Mode: Most of the variables in this factor describe the presentation mode for the advance organizers and learning materials. This factor had low correlations with the dependent variables.

Factor V - Kinetic Structure: This factor was identified as a kinetic structure factor because of the loadings for commonality and progression density. The loading of achievement on this factor is interesting in that the

TABLE 15

FACTOR III - SUBJECT

Independent Variable		Loading	Correlations Dep. Var. #1 t-statistic	Dep. Var. #2 Probability
25	Science	0.85	-0.21	-0.33
27	Other Subjects	-0.56	0.25	0.29
28	Concept Type	0.62	-0.19	-0.28
43	Concrete Exp.-AO	0.40	0.09	0.04
44	Diagrams in AO	0.39	0.17	0.08
47	Lab in LM	0.68	0.03	-0.08
49	Control of LM	0.38	-0.11	-0.17
Factor III			-0.23	-0.19

TABLE 16

FACTOR IV - PRESENTATION MODE

Independent Variable		Loading	Correlations Dep. Var. #1 t-statistic	Dep. Var. #2 Probability
28	Concept Type	-0.30	-0.19	-0.28
33	Check Alt. Hyp.	-0.43	0.10	0.04
42	Mode for AO	0.46	0.25	0.25
44	Diagrams in AO	0.47	0.17	0.08
45	Questions in AO	0.60	0.00	0.04
46	Mode for LM	0.70	0.07	0.00
48	Questions in LM	0.63	0.02	-0.01
50	AO Reading Level	0.37	0.13	0.26
53	Prog. Density	-0.36	-0.23	-0.23
Factor IV			0.10	0.12

kinetic structure variables were intended to be measures of the learning difficulty of the advance organizers and the achievement variable is related to the learning difficulty of the learning materials. The presence of the achievement variable in this factor lends support to the validity of the kinetic structure variables as measures of learning difficulty. The correlations of this factor with the dependent variables were quite low.

Factor VI - Teaching Strategies: The three variables with high loadings on this factor all measure the tendency toward or away from a pure teaching strategy. This factor had very low correlations with the dependent variables.

Summary: The six factors identified for the independent variables were called length of the advance organizer, treatment administration conditions, subject area, presentation mode for the materials, kinetic structure, and teaching stategies. Treatment administrazion conditions and subject matter were the only factors which had significant correlations with the dependent variables.

TABLE 17

FACTOR V - KINETIC STRUCTURE

Independent Variable	Loading	Correlations	
		Dep. Var. #1 t-statistic	Dep. Var. #2 Probability
10 Achievement	0.60	0.15	0.11
32 Test Ans. in AO	0.30	0.25	0.18
38 Wrong Unit	0.56	-0.07	-0.18
49 Control of LM	0.42	-0.11	-0.17
52 Commonality	-0.65	-0.04	0.01
53 Prog. Density	0.56	-0.23	-0.23
Factor V		-0.08	-0.05

TABLE 18

FACTOR VI - TEACHING STRATEGIES

Independent Variable	Loading	Correlations	
		Dep. Var. #1 t-statistic	Dep. Var. #2 Probability
56 50% C - 50% E	-0.85	0.06	-0.02
60 All C or All E	0.91	-0.11	-0.04
61 % C or E	0.96	-0.16	-0.11
62 % CEC	-0.41	0.25	0.13
63 % EC	-0.35	-0.11	-0.08
Factor VI		0.07	0.00

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The present study was a meta-analysis of selected advance organizer research reports. The study was undertaken because there is a large amount of research in this area, but literature reviews that have attempted to integrate this research have generally failed to reach any definitive conclusions. The purpose of the analysis was to determine whether or not there were any characteristics of the experimental settings or materials that had consistent relationships with the treatment effects obtained through the use of advance organizers.

The procedures involved the identification of advance organizer research reports, the collection of the experimental materials, and the detailed analysis of these reports and materials. The units of analysis were research reports of experiments for determining the facilitative effects of specific advance organizers for specific sets of learning materials involving comparisons of achievement for groups that received advance organizers with achievement for groups that did not receive advance organizers. The sample consisted of 99 such experiments reported in 77 research reports. A total of 91 different advance organizers was identified and copies were obtained for 71.

A number of variables were defined and quantified to enable the coding of data from the reports and materials. The two dependent variables were measures of the magnitude of the difference between the achievement means for the advance organizer and control groups. The independent variables described characteristics of the sample, treatment administration conditions, type of subject matter, quality of the research procedures, and characteristics of the advance organizers and learning materials.

The data analysis involved the computation of descriptive statistics, the examination of the relationships between independent and dependent variables by correlation coefficients and stepwise multiple regression analysis, and the examination of the inter-relationships among the independent variables by factor analysis.

Of the 99 t-statistics computed for the experimental comparisons between advance organizer and control groups, 68 were positive indicating that the observed means for the advance organizer groups were higher than those for the control groups. Twenty-two of these positive t-statistics were statistically significant while none of the twenty-nine negative t-statistics were significant. There were two t-statistics that were zero.

Ten of the sixty-three independent variables had significant correlations with both dependent variables. Seven had significant correlations with one dependent variable but not the other. Eight relationships between independent and dependent variables had been predicted prior to the data analysis and four of these predictions were supported by the obtained correlation coefficients. The four that were supported were those related to grade level, gain score, reading level, and progression density. The other independent variables which had significant correlations with the dependent variables were four administration condition variables, four subject matter variables, two variables related the internal validity of the experiments, the type of advance organizer, and the CEC teaching strategy.

Although the independent variable, ability level, did not have a significant correlation with the dependent variables, a number of factors were identified which were related to the ability by treatment interaction. Some of these were subject area, cognitive level of the test questions, and various characteristics of the experimental materials.

The five independent variables entered in the regression analysis accounted for approximately 30% of the variance in the dependent variables. The six factors identified for the independent variables were called length of the advance organizer, treatment administration conditions, subject area, presentation mode for the materials, kinetic structure, and teaching strategies. Treatment administration conditions and subject matter were the only factors having significant correlations with the dependent variables.

Conclusions

On the basis of the frequency of significant results showing facilitative effects for advance organizers and the absence of negative results, it appears that the advance organizer can be an effective instructional device.

The main conclusion that can be drawn from the results of the analysis reported in the present study is that there are a number of experimental factors and characteristics of the advance organizers that have shown a relationship to the effects obtained through the use of advance organizers. Some of the variation in the results reported in advance organizer research can be accounted for by the variation in these variables from study to study. The following conclusions relate to specific variables or groups of variables.

Some of the significant findings in favor of advance organizers may have been due to the possible contribution of the advance organizer alone to answering the test questions or to an inequality of study time for the treatment groups.

The relationship between type of advance organizer and the dependent variables was probably the most fundamental relationship identified. There was an indication that comparative advance organizers may be more effective than expository ones.

Student inability to understand the advance organizer information may account for some of the non-significant results. Advance organizers are probably more likely to show facilitative effects when the reading level is appropriate to the grade level, when the rate of introduction of new ideas is slower, when the content is less complex, and when students are given more time to process the advance organizer information.

The treatment by ability interaction effect tends to favor the high ability group when the percentage of higher level questions in the achievement test is increased, when mathematics content is used, and when the length of the advance organizer is increased. The low ability group tends to be favored when the content is other than science or mathematics. A number of specific characteristics of the materials also correlated with this interaction.

The dependent variables had significant correlations with subject area, concept type, and grade level indicating that advance organizers may be less effective when the subject matter is science, more effective for classificational concepts, and more effective at the higher grade levels.

The inter-relationships among these three independent variables make any conclusions concerning the individual variables very tentative. It is quite probable that the relationship of science content with the dependent variables was largely due to the fact that most of the advance organizer research in science has used correlational concepts and a large portion of the research done at the elementary school level has used science content. The observed relationships between these three variables and the dependent variables could be due to the possibility that it may be more difficult to write effective advance organizers under certain conditions. For example, it is possible that good advance organizers are just as effective for elementary students as for university students, but it may be more difficult to write good advance organizers for elementary students. It may also be easier to identify and provide subsumers for classificational concepts than for correlational concepts.

Recommendations

Recommendations in three areas are discussed in this section. The first set of recommendations pertain to meta-analysis in general. The second set suggests possible ways to extend the meta-analysis of advance organizer research. The third set contains suggestions for future advance organizer research.

Meta-analysis: A comparison of the conclusions in the present study with those in the literature reviews of advance organizer research can serve to illustrate the value of meta-analysis as a research tool. In the present study a number of conclusions based on the relationships that were identified between the dependent and independent variables were made while the general impression given by the literature reviews is that the results of the advance organizer research are contradictory and inconclusive, and that it was difficult to form any generalizations from these results. There are a number of areas in educational research that could probably benefit from a meta-analysis of the existing research.

The dependent variable to be used in a meta-analysis must be carefully selected because this selection will usually delimit the scope of the analysis. For example, the dependent variables in the present study were measures of the difference between achievement means for a group receiving an advance organizer and a group which did not receive one. Therefore, experimental comparisons of the relative effectiveness of different kinds of advance organizers were excluded from the analysis.

Another decision that must be made concerning the dependent variable is how it is to be measured. In the present study, very similar results were obtained using a t-statistic and a probability level. The correlation between the two variables was 0.88. Another possibility would be some type of scale indicating the presence and direction of significant differences between treatment groups. In the following example of such a scale the experimental and control group means are represented by EG and CG respectively:

2 - EG significantly higher than CG.
1 - EG higher than CG but not significant.
0 - EG equal to CG.
-1 - CG higher than EG but not significant.
-2 - CG significantly higher than EG.

The upper and lower ends of this scale could be extended to distinguish between the 0.001, 0.01, and 0.05 alpha levels. When a seven point scale of this type was generated from the dependent variables in the present study, the correlations of this scale with both dependent variables were 0.88. Further examination of the effects of using different scales to measure the dependent variable should be done in future meta-analysis research.

The advantages of this type of scale over the t-statistic used in the present study are that it is easier to generate and some research reports do not provide the treatment group means and standard deviations required to compute a t-statistic. However the dependent variable in a meta-analysis should be computed from the most basic data provided in the research report to avoid conclusions based on inappropriate data analysis procedures used in the original research.

At the planning stages of a meta-analysis, existing literature reviews can be very helpful in the identification of independent variables. Since the list of independent variables may change during the data collection, it is very helpful to keep extensive notes on each report as it is analyzed. It is especially important to note any characteristics that had not been defined in the list of independent variables. These notes can sometime suggest additional variables.

Meta-analysis of AO Research: The present study could be extended to include a wider range of advance organizer research. The research reports that could be added are those which compared the relative effectiveness of advance and post organizers, different kinds of advance organizers, and different kinds of pre-instructional strategies such as advance organizers, behavioral objectives, and pre-test questions. This study could also be extended by modifying the list of independent variables. One possibility would be to provide a more detailed description of the learning materials.

Future Advance Organizer Research: The first recommendation pertaining to future advance organizer research concerns the basic definition of the term advance organizer. As was indicated in Chapter II, the advance organizer literature tends to use the terms subsumer and advance organizer interchangeably. The distinction between a subsumer as a concept in cognitive structure and an advance organizer as a set of introductory instructional materials should be clearly maintained in all discussion. This distinction is important both in designing research and in interpreting the results in relation to Ausubel's subsumption theory of meaningful verbal learning. More research attempting to answer the following two questions is needed: do subsumers already in cognitive structure facilitate learning, and are advance organizers an effective means of generating subsumers. Most of the existing research has combined these two questions into the question, do advance organizers facilitate learning.

Since the role of subsumers in meaningful learning is a major component of Ausubel's learning theory, research indicating that subsumers in cognitive structure do not facilitate learning would have serious implications for the validity of the theory. The use of advance organizers is an application of this theory to the construction of learning materials. Therefore, research indicating that advance organizers are not effective would not mean that the theory is not useful. There may be alternate approaches to assuring that relevant subsumers be available for new learning such as the careful long-term sequencing of materials. In generalizing the results of advance organizer research to Ausubel's theory, it must be noted that the use of advance organizers is not the only means through which meaningful verbal learning can occur.

The second recommendation concerns the research design of experiments for determining whether or not advance organizers facilitate learning. Elements should be included in the design to check on alternate explanations for the results. The basic design for this research has involved the comparison of a group receiving an advance organizer followed by learning materials and a test, with a group that received a control introduction or nothing followed by learning materials and a test. When facilitative effects were observed, it was assumed that the advance organizer generated a subsumer which aided the incorporation of the new material into cognitive structure. However the following alternate explanations could account for the results:

1. The advance organizer information alone could have helped to answer the test questions.
2. The improved performance of the advance organizer group could be due to extra study time on relevant materials.

Generalizations beyond a specific study would be questionable if some attempt had not been made to show that these alternate explanations did not apply. Future advance organizer research should include tests for both of these explanations. Some of the existing research has dealt with one or both of these concerns.

A more serious generalization problem exists if nonsignificant results were obtained in the experiment. Nonsignificant results for experiments using the model described above probably have very little implication for Ausubel's theory. The following explanations for such results do not question the validity of the theory:

1. If the students already possessed relevant subsumers prior to the experiment, the main function of the advance organizer would have been previously achieved so it would be less likely that differences between treatment groups would be observed.
2. If students were unable to understand the advance organizer information, there would have been no opportunity for a subsumer to be established.
3. The main concept in the advance organizer may not have been an appropriate subsumer for the information in the learning materials.

The first two could be experimentally tested while the third one would have to be checked through the use of expert judges in the content area.

The check on the first two alternate explanations mentioned above would involve testing on the advance organizer information prior to and after exposure to that advance organizer. The prior test would measure the extent to which the students already understood the concepts in the advance organizer, and the gain score would measure the level of understanding achieved through the exposure to the advance organizer. Since this testing would interfere with the equality of the treatment of the groups in the experiment, it should be done with equivalent groups during the development of the advance organizer. Pre-testing on the learning material information does not constitute an appropriate test of whether or not students have a subsumer. It is possible for the students to be totally unfamiliar with the facts in the learning materials but still possess a subsumer to which they could be linked. For example, students could be totally unfamiliar with homeostatic systems, but have a good understanding of the concept of dynamic equilibrium which these systems illustrate. Equating treatment groups with respect to prior knowledge is not a satisfactory way to deal with this problem either. If experimental and control students both entered the experiment possessing the subsumer which the advance organizer was designed to establish, there is no reason to expect the experimental group to be much different from the control group after exposure to the advance organizer.

A further confounding factor is the possible affective effects of the control introduction. If the control introduction were more interesting or boring than the advance organizer, the performance of the control group could have been affected by their increased or decreased state of arrousal. It may be possible to obtain an indication of student interest in the introductory passages and compare the responses to the advance organizer with the responses to the control introduction.

The remaining recommendations pertain to the construction of experimental materials. The identification of the concept which is to act as the subsumer for the information in the learning materials is probably the most critical decision to be made during the construction of the advance organizer. One approach which might help to select an appropriate subsumer is to construct a concept map for the concepts to be taught in the learning materials. This could be a pyramid or tree-type diagram which shows the relationships among the concepts and also shows which concepts are subsumed by others. It should then be possible to identify a broad concept which subsumes the entire structure. An attempt should be made to present only one main concept in the advance organizer. The results of the present study showed that advance organizers had a lesser tendency to show facilitative effects as the number of concepts in the advance organizer increased.

Once the advance organizer has been constructed, judges could be asked to identify the main concept in the advance organizer and to show how the concepts and facts in the learning materials are subsumed by it. If the main concept in the advance organizer cannot be identified through a careful analysis, it is quite probable that this concept will not be established as a subsumer when the students read the advance organizer.

Once the potential subsumer has been identified, it must be developed in the advance organizer in terms that the students will be able to understand. An advance organizer cannot possibly function effectively if the students cannot understand it. Student reactions to the materials should be obtained during the development of the advance organizer. The results of the present study indicated that comparative advance organizers may be more effective than expository ones. This effect emphasizes the need to find out what the students already know related to the topic and to incorporate this familiar information into the advance organizer. Another relationship identified in the present study was that the advance organizers had a greater tendency to show facilitative effects when the presentation mode was other than the reception of verbal information from text. The advance organizer should incorporate concrete experience and audio-visual aids whenever possible. Although Ausubel (1970, pp. 1-4) states that advance organizers should be written at a higher level of abstraction and generality than the learning materials, they must not be so abstract that the students cannot cope with them. It is possible to develop a general concept but still make use of very specific concrete examples. The results of the present study indicate that the presentation of a generalization followed by examples followed by a restatement of the generalization may be an effective teaching strategy for advance organizers.

The kinetic structure analysis techniques developed by O. R. Anderson (1971) could possibly be used to improve the advance organizer. The coefficients that were used in the analysis in the present study are only a small portion of this analysis procedure. This technique enables the identification of structures within the learning materials which indicate where new material is being introduced and the extent to which it is elaborated.

The achievement tests used in the advance organizer research have stressed the recall of facts. When higher level questions were used, they generally tested for the application and comprehension of specific attributes of concepts. Future research should attempt to obtain a more extensive measure of the students' ability to understand and use the concepts. The techniques developed at Cornell University for the construction of cognitive maps may be applied to this end (Hibbard and Novak, 1975). In this technique, information gained through interviews is used to construct a cognitive map which contains the concepts that the student was able to recognize and shows the relationships that the student perceived between concepts.

A large portion of the existing advance organizer research has dealt with correlational or theoretical concepts. This is particularly true in the area of science. Of the forty-two science concepts identified, only four were categorized as classification. More research should be done with classificational concepts.

The final recommendation pertains to learning materials used in advance organizer research. More research is needed which investigates the relative effectiveness of an advance organizer with learning materials that vary in their organizational properties. It is possible that certain patterns within the learning materials may serve a similar function to that served by advance organizers. Therefore, advance organizers may be more important for some kinds of learning materials than for others.

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Appendix A

Procedure for Determining Reading Level

Procedure for Determining Reading Level (Fry, 1968)

1. Select three one-hundred-word passages from the beginning, middle, and end of the reading materials. Proper nouns are excluded from all computations. For the present study, if the reading materials were less than six hundred words long, the complete passage was analyzed.

2. Count the number of sentences in each passage to the nearest tenth of a sentence and average the three values.

3. Count the number of syllables in each passage and average the three values.

4. If there is a great deal of variation among the values obtained for the three passages, select additional passages and include their values when computing the averages. For the present study, if the reading levels for the three passages had a spread of more than two grades, a total of six one-hundred-word passages were used.

5. Plot the average number of sentences and syllables per one hundred words on the graph to obtain the reading level.

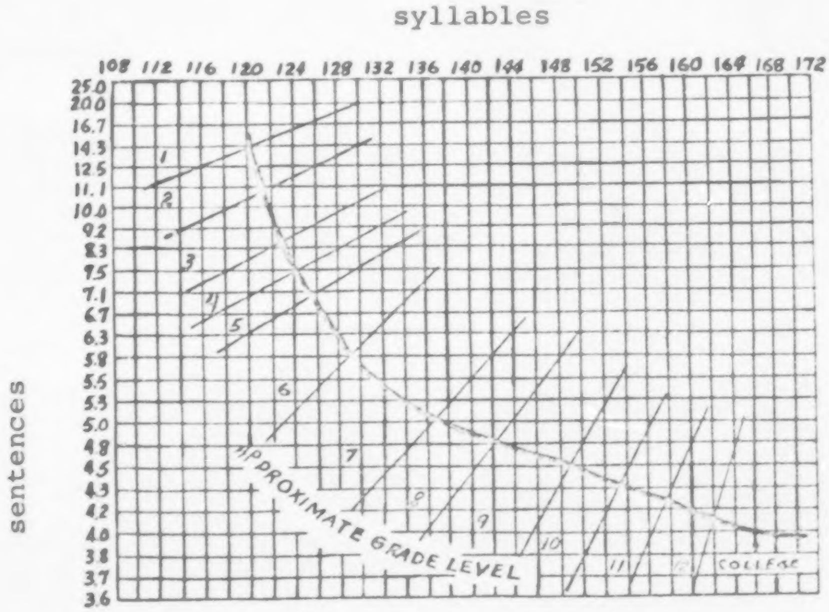


Figure 1

READING LEVEL GRAPH

Appendix B

Coding Procedures for Kinetic Structure Analysis

Coding Procedures for Kinetic Structure Analysis

This appendix outlines the coding procedures for obtaining the data required in kinetic structure analysis. These procedures are illustrated with a sample analysis of a short passage. There are three steps in the coding procedures: identification of the discourse units, identification of the unique verbal elements in the entire passage, and identification of the verbal elements in each discourse unit.

1. Identification of Discourse Units

The basic discourse unit is the sentence consisting of subject, predicate, and subordinate clauses. Clauses connected by conjunctions such as and, but, and so are divided at the conjunction to form separate discourse units. If - then statements are not separated into two discourse units. These specifications have been taken from the list provided by O. R. Anderson (1971, pp. 29-31).

2. Identification of Unique Elements

The second step is the construction of a numbered list of the verbal elements in the passage. A verbal element is a word or phase which contributes to the substantive meaning of the communication. Each element must be included only once on the list. The following guidelines for identifying elements is a modification of the list provided by O. R. Anderson (1971, pp. 31-33):

- All technical terms are identified as elements.
- Elements tend to be nouns, adjectives, or verbs (listed in order of importance).
- An element can be a single word or a phrase such as death rate and theory of evolution.
- Synonyms and pronouns are not identified as separate elements.

-- Verb and adjective forms of a noun are not identified as separate elements. For example, learning as a noun is not a different element from learn as a verb.

-- When identifying elements, it is better to err in the direction of larger numbers of elements.

3. Identification of Elements in Discourse Units

The third step is to list the elements in each discourse unit. Each element is listed only once in a given discourse unit.

Sample Analysis

A sample analysis for a short passage is presented below. The passage is the advance organizer developed by Lucas (1972). The verbal elements are listed below the passage and the results for the analysis are presented in Table 19. The end of each discourse unit in the passage is marked by a /.

Passage

The sun is the source of all energy./ Green plants get energy from the sun./ Insects, which are many in number, eat the green plants around them/ and they in turn are eaten by insect-eating animals such as frogs and fish./ These insect-eaters (frogs and fish) serve as food for flesh-eating animals such as snakes and birds of prey./ These flesh-eaters are larger in size but fewer in number./

Verbal Elements

1. sun
2. source
3. energy
4. green plants
5. insects
6. many in number
7. eat
8. insect-eating animals
9. frogs
10. fish
11. food
12. flesh-eating animals
13. snakes
14. birds of prey
15. larger in size
16. fewer in number

Table 19 contains the list of elements in each discourse unit. The coefficients for each adjacent pair of discourse units and for the passage are included.

The commonality coefficient for each adjacent pair of discourse units is the ratio n_c/n_t, where n_c is the number of elements that the two units have in common and n_t is the total number of elements in the two units (O. R. Anderson, 1971, p. 13). For example, this ratio is 4/6 for the first pair.

The progression density coefficient for each adjacent pair of discourse units is $(1-B_1)n$, where B_1 is the commonality coefficient for that pair and n is the number of elements in the second member of the pair which did appear in any previous discourse unit (O. R. Anderson, 1971, p. 17). For example, this coefficient is $(1-0.67)\times 1$ for the first pair. O. R. Anderson (1971, p. 18) assigns a value of zero for this coefficient for the first discourse unit. For the analysis in the present study, no value was assigned to the first unit because coefficients were obtained for materials which varied greatly in length. A zero value for the first unit would have a greater influence on the average value for short passages than for long passages.

TABLE 19

RESULTS OF THE SAMPLE KINETIC STRUCTURE ANALYSIS

Discourse Unit	Elements	Commonality Coefficient	Progression Density Coefficient
1	1,2,3	--	--
2	4,3,1	0.67	0.33
3	5,6,7,4	0.29	2.14
4	5,7,8,9,10	0.44	1.67
5	8,9,10,11,12,13,14	0.50	2.00
6	12,15,16	0.20	1.60
	average	0.42	1.55

Appendix C

Procedures for Identifying Teaching Strategies

Procedures for Identifying

Teaching Strategies

Prior to the teaching strategy analysis, the major concept or concepts contained in the advance organizer were identified and a list consisting of all those attributes specified in the advance organizer was generated for each concept. Teaching strategies were done in relation to these concepts.

The first steps in the identification of the teaching strategies used to develop the major concepts in the advance organizers were the identification and classification of the instructional moves. After all the moves had been specified, the teaching strategies were identified by grouping selected moves together.

1. Identification of Instructional Moves

A move constitutes the description of a single attribute or the identification of a single example which is relevant to the major concept. Grammatical structure was not considered in the identification of moves. A single sentence could contain more than one move or a single move could contain several sentences.

2. Classification of Instructional Moves

Each move was classified as an exemplification move or a characterization move. The following techniques used in teaching concepts are exemplification moves:

-- identifying an example.

-- identifying a nonexample.

-- identifying a familiar subset.

The following methods of providing information to clarify the meaning of a concept are characterization moves:

-- describing an attribute.

-- specifying a sufficient condition.

- naming a familiar superset.
- providing a definition.
- providing an analogy.
- indicating how members of the referent set are different from nonmembers.
- explaining why a particular example is an example.

The above definitions of exemplification and characterization moves are based on those provided by Henderson (1967, pp. 575-577). There are two major differences between the above definitions and those used by Henderson. One difference is that Henderson classified the identification of a subset as a characterization move while it is specified as an exemplification move in the above listing. The reason it was called an exemplification move is that it was felt that the identification of a subset would tend to bring to mind members of the subset rather than general characteristics of the members. The second difference is that Henderson (1976, p. 576) classified exemplification with justification as a single move. For the analysis in the present study, this was split into two moves. The identification of the example was classified as an exemplification move and the justification was classified as a characterization move.

3. Identification of Teaching Strategies

A teaching strategy is defined by a specific sequence of instructional moves. The six strategies that were considered in the analysis in the present study are C, E, CEC, EC, CE, and ECE where C represents a characterization move and E represents an exemplification move. The instructional moves were clustered according to the attributes of the concept; all of the consecutive moves pertaining to a particular attribute were identified as a strategy. Each cluster was then classified as one of the six strategies identified above. In a sequence consisting of C moves describing several attributes followed by examples to illustrate these attributes, the individual C moves were not identified as separate strategies. The complete sequence was identified as a CE strategy.' The first and last moves in the cluster are the most important in determining the strategy. For example, the sequence CEECCE would be classified as a CE strategy.

Note: Only the instructional moves pertaining to the attributes of the major concepts were considered in the identification of the teaching strategies, but the information pertaining to subconcepts was not ignored in the analysis. Instructional moves for the subconcepts were identified and tabulated to give an indication of the extent to which the advance organizer contained ellaboration of the subconcepts. The following two statements on the concept, square, illustrate the coding of subconcept moves:

-- Squares have four right angles.

-- A right angle is 90°.

The first statement is a characterization move for the concept square. The second is a characterization move for the subconcept right angle.

Sample Analysis

The results of the analysis of the following passage illustrate the procedures outlined above. The major concept for the passage is air pressure for which the following three attributes were identified:

-- air pressure is caused by molecules.

-- air pressure can do work.

-- air pressure is less in moving air masses than in stationary air masses.

In the passage, the end of each instructional move pertaining to air pressure is marked by a / and a C or E is placed above it to designate a characterization or exemplification move respectively. The moves pertaining to the subconcepts are designated by sc and se placed above them.

Passage - Advance Organizer

for Ryder (1970)

The air is all $\overset{sc}{\text{around}}$ us, although it cannot $\overset{sc}{\text{be}}$ seen. For the most part, air is a mixture $\overset{sc}{\text{of}}$ gases. The air $\overset{sc}{\text{is}}$ made up of very very tiny $\overset{sc}{\text{particles}}$ called molecules. These molecules of air actually have $\overset{sc}{\text{weight}}$ and take up $\overset{sc}{\text{space.}}$ Since they have weight and take up space, they can exert a push or pressure. $\overset{C}{/}$ [Students were shown a transparent box with ping-pong balls that was shaken to demonstrate moving mollecules pushing on a surface.] $\overset{E}{/}$ You recall that air is used to blow up a balloon.[1] Within the balloon, the molecules of air push against each other, as well as against the wall of the balloon. If air presses or pushes much harder one way than another, it could cause something to move, $\overset{C}{/}$ and if anything moves when air pushes against it, we see the results of air doing some kind of work. $\overset{C}{/}$ [Students were shown a balloon being blown up.] $\overset{E}{/}$

When air is moving very fast along the side of an object, some of its molecules may not hit the side of the object enough times or hard enough to cause a push on it. As a result, the fast-moving air does not press strongly on the surface of the object. In other words, the fast-moving air exerts a very weak push on the sides of the things that it moves over. $\overset{C}{/}$ On the other side of the object, there is a push from the air that is standing still, which is stronger than the weak push of the fast moving air. The difference in the push of the air on the opposite sides of the object could cause the object to move. $\overset{C}{/}$ [Causing a piece of paper to move by blowing over one side was demonstrated.] $\overset{E}{/}$

---

[1] In the initial analysis, this statement was overlooked as a possible E move to be grouped with the three moves following it to form an ECCE cluster. It is not immediately evident that this is an example of air pressure doing work so it was simply considered as preamble to the next C move. Upon reconsideration, it should probably be coded as an E move.

The instructional moves in the above passage were placed into three clusters: CE / CCE / CCE. All three are CE strategies so 100% of the moves are in a CE strategy. There were 7 moves identified for the subconcepts.

The following example illustrates the procedures for calculating the per cent of moves in each strategy. If the sequence of moves in the advance organizer were CCEEC / ECC / CCEE / CEC, the strategies for the four groups would be CEC, EC, CE, and CEC respectively. Counting the number of moves in each strategy and dividing by the total number of moves would give the following percentages:

CEC - 8/15 = 53%.

EC - 3/15 = 20%.

CE - 4/15 = 27%.

Appendix D

Raw Data Tables

The raw data for all cases are presented in Tables 21-24. The numbers identifying the source for each data set in these tables correspond to the numbers in Table 20 which lists the authors and descriptive notes for each data set. In cases for which more than one data set was generated from a given report, the sources are further identified by topic or treatment descriptions. The topics used for this purpose correspond to the headings which precede the advance organizers in Appendix G. The descriptive notes identify the procedures used to compute the dependent variables when standard t-statistics were not obtained. For cases in which some aspect of an experiment was excluded from the analysis, the specific portion of the data that was used is identified.

The raw data for variables 1-24 are presented in Table 21. The ability and retention variables (8, 18 and 19) have been omitted from this table. The raw data for variables 25-49 are presented in Table 22. The raw data for variables 50-65 are presented in Table 23. The number of subjects, the means, and the standard deviations that were used in the computation of the dependent variables are presented in Table 24. The values for the dependent variables are also given in Table 24. The statistics for the additional data sets that were generated for the ability and retention measure variables are included in Table 24. These cases are identified by the ability level or by the number of days for the retention test.

TABLE 20

SOURCES AND NOTES FOR RAW DATA TABLES

No.	Source	Notes
1	Andreozzi (1975)	Results were collapsed across class and question-type levels. Review questions used as control introductions were considered as extra practice time for the control group.
2	Andrews (1972-73)	A significant F-ratio was reported, but the t-statistic based on the means and standard deviations was not significant.
3	Ausubel (1960).	
4	Ausubel and Fitzgerald (1961)	comparative advance organizer - The standard deviations were estimated from t-statistics and means for subgroups. Number of subjects per cell was estimated from total N divided by the number of cells.
5	Ausubel and Fitzgerald (1961)	expository advance organizer - See 4.
6	Ausubel and Fitzgerald (1962)	Dependent variables were computed from contrasts based on a treatment by ability analysis of variance.
7	Ausubel and Youssef (1963)	comparative advance organizer - Dependent variables were computed from contrasts using adjusted means. The Zen Buddhism section was not used.
8	Barron (1970)	grades 6-8.
9	Barron (1970)	grades 9-12.
10	Barrow (1973)	Dependent variables were computed from contrasts based on a treatment by ability by time analysis of variance. The group receiving the historical introduction was used as the control group.

TABLE 20 (continued)

No.	Source	Notes
11	Bernard (1975)	Dependent variables were computed from results of the concept master test only.
12	Bertou (1971)	Results were collapsed across question and no question levels. Dependent variables were computed from contrasts based on an analysis of variance.
13	Billey (1969)	learning - Dependent variables were obtained from a reanalysis using analysis of covariance on the raw data with SCAT as the covariate. Significant differences in favor of the advance organizer group were identified while nonsignificant results were reported.
14	Billey (1969)	behavioral objectives - Dependent variables computed as in 13 above.
15	Blount, et. al. (1967)	Results for the test on the first two lessons were used. Only the lesson one advance organizer was analyzed.
16	Bonner (1974).	
17	Brewer (1974)	Dependent variables were obtained from F-ratio for analysis of covariance.
18	Brovey (1969)	A matched-pair t-test was used.
19	Callihan (1975)	Results for the multiple choice test and the concept comprehension section of the free response test were used.
20	Caponecchi (1973)	The group receiving the introductory overview was not used. Analysis of covariance was used.
21	Clawson (1972)	Results for the test on the first three chapters were used.
22	Dawson (1965).	
23	Eastman (1977)	analytical AO.

TABLE 20 (continued)

No.	Source	Notes
24	Eastman (1977)	graphical AO.
25	Edwards (1976)	grade 3 - Only the results for the focused organizers were used. Variable 12 was coded as only one advance organizer because the topics were totally unrelated.
26	Edwards (1976)	grade 4 - See 25.
27	Edwards (1976)	grade 6 - See 25.
28	Felker (1973)	Results were collapsed across question and no-question groups.
29	Feller (1973)	The group receiving the historical introduction was used as the control group. Results of the analysis of covariance were not used.
30	Fitzgerald (1962)	Adjusted means were used.
31	C. J. Graber (1975)	algebraic AO - Only the groups receiving the four teacher questions were used.
32	C. J. Graber (1975)	geometric AO - See 31.
33	R. A. Graber (1972)	Results were collapsed across organizing ability levels.
34	Grotelueschen (1967)	base 7 AO - Only the results for the high and low ability groups were read. Means for the combined groups were estimated from the graph (1967, p. 559). The means for the high ability group were obtained from the journal article (Grotelueschen and Sjogren, 1968). Means for the low ability group were computed from means for combined and high ability groups.
35	Grotelueschen (1967)	base 10 AO - See 34.
36	Grotelueschen (1967)	general bases AO - See 34.
37	Harrington (1968).	

TABLE 20 (continued)

No.	Source	Notes
38	Hartje (1974)	axiomatic systems AO - Results were combined for grade 12 and university students.
39	Hartje (1974)	combined AO - See 38.
40	Hawkins (1972)	Combined scores for recall of specific terms and recall of relationships were used. The advance organizer group was contrasted with an average of the CI and NAO groups using a Scheffe contrast.
41	Hershman (1971)	Unit II - Results were reanalyzed using class as the unit of analysis.
42	Hershman (1971)	Unit III - See 41.
43	Hershman (1971)	Unit IV - See 41.
44	Hoffelder (1973)	The sum of the four test scores was used and results were reanalyzed using analysis of covariance with chemistry score as the covariate.
45	Hysell (1973).	
46	Jerrolds (1967)	one sentence AO - Results were collapsed across groups receiving instructions and not receiving instructions on the use of AOs.
47	Jerrolds (1967)	long AO - See 46.
48	Jones (1977)	abstract AO - Only the results from the journal article (1977) were used.
49	Jones (1977)	concrete AO - See 48.
50	Kahle (1971)	Only results for Unit I were used.
51	Kahle and Rastovac (1976)	Dependent variables were based on an F-ratio for a one-way analysis of variance.
52	Kennedy (1974)	Dependent variables were computed from contrasts based on a treatment by ability by cognitive structure analysis of variance. Results for the retention measure were not used.

TABLE 20 (continued)

No.	Source	Notes
53	Kersten (1976)	Results were combined for the fall and spring quarter experiments. Analysis of covariance was not required for the combined groups.
54	Kirkwood (1970)	The group receiving the placebo introduction was used as the control group.
55	Koran and Koran (1973)	examples AO.
56	Koran and Koran (1973)	no examples AO.
57	Kuhn (1967)	Results were reanalyzed using class as the unit of analysis.
58	Lawrence (1970)	Results were collapsed across pretest and no pre-test levels.
59	Lewis (1972)	Only the rsults for the final test were used. Results were combined for Norwegian and Swedish groups using an unweighted mean.
60	Lucas (1972).	
61	Luderer (1976)	caves - The results for the other topics were not used because it was felt that the materials used as advance organizers were only topic statements.
62	Malone (1970)	Only the results for study II were used.
63	McMeen (1974)	small step size - Only the results for the superordinate sentences were used.
64	McMeen (1974)	large step size - See 63.
65	Montano Midence (1974)	Only the results for the written advance organizer were used.
66	Munford (1971)	The results for the analysis of covariance were not used because adjusted means were not given.

TABLE 20 (continued)

No.	Source	Notes
67	Murchison (1975) - abstract AO	The sum of the scores for test A and test B were obtained from the raw data and results were reanalyzed using this sum.
68	Murchison (1975) - concrete AO	See 67.
69	Neisworth (1968)	Results for the retarded students were not used.
70	Peterson et. al. (1973); Peterson (1971) - grade 8.	
71	Peterson et. al. (1973) - university students.	
72	Prescott (1976).	
73	Price (1973).	
74	Pucel (1966) - metalworking	Results for the transfer tests were not used.
75	Pucel (1966) - communication	See 74.
76	Ratzlaff (1970)	Results for the rote presentation mode were not used.
77	Rickards (1975-76)	Only the results for the superordinate sentences and for the recall of related facts were used.
78	Romberg and Wilson (1973)	The group receiving no introductory materials was used as the control group. Dependent variables were computed from contrasts based on a three-way analysis of variance.
79	Ryan (1968)	Only the results for the advance organizer consisting of the 30 minute lecture were used. Dependent variables were computed from contrasts based on a treatment by anxiety level analysis of covariance. Results were collapsed across anxiety levels.
80	Ryder (1970)	Results were collapsed across sex, background, and grade levels. Dependent variables were computed from raw means rather than adjusted means because there was not much difference.

TABLE 20 (continued)

No.	Source	Notes
81	Santiesteban and Koran (1977).	
82	Saretsky (1975)	anthropology.
83	Saretsky (1975)	science.
84	Saretsky (1975)	literature.
85	Scandura and Wells (1967)	The combined results for tests I and II were used. Results for the topic, topology, were not used because the nature of the discussion of the game used as the advance organizer was not clarified in the report.
86	Schnell (1973)	Means and standard deviations were obtained from the author. The results of the regression analysis reported by Schnell did not agree with the results of the t-test based on the means.
87	Schulz (1966)	conservation - The results for the ability level breakdown were not used.
88	Schulz (1966)	metabolism - See 87.
89	Slock (1974).	
90	Smith (1970)	electricity - Only the results for the low vagueness passages and the synonym replacement test were used.
91	Smith (1970)	jungle forests - See 90.
92	Tavares (1976).	
93	Thelen (1970)	Only the topic, waves, was used.
94	Toth (1975)	The results for the analysis of covariance were not used.
95	Townsend (1969)	classroom instruction - The results were reanalyzed using group mean as the unit of analysis.
96	Townsend (1969)	programmed instruction - See 95.

TABLE 20 (continued)

No.	Source	Notes
97	Weisberg (1970)	Dependent variables were computed from the reported difference between the means and the error term for an analysis of variance.
98	West and Fensham (1976)	Results were collapsed across prior knowledge and grade levels. Results for study 2 were not used.
99	Wong (1972).	
100*	Young (1975)	Results were combined for the three subject area groups.

* The data set for this study was inadvertently omitted from the data analysis. This study used the same materials as Ausubel (1960) and obtained similar results. When a correlation matrix was obtained with this data set included, the correlations of the independent and dependent variables were not much different from those obtained without this data set. The largest change in any one coefficient was 0.02.

TABLE 21

RAW DATA FOR VARIABLES 1-24

	Variable Numbers																				
Source	1	2	3	4	5	6	7	9	10	11	12	13	14	15	16	17	20	21	22	23	24
1	-1.15	-0.746	0	0	75	63	9.0		63		6	1	0	0	1	0	2200				
2	1.37	0.826	0	0	72	124	7.0		72		1	1	0	0	1	0	259				
3	2.08	0.959	0	0	60	80	13.0	20	43	19	1	2	0	0	1	0	478	10	2500	35	0.24
4	1.91	0.941	0	0	61	100	13.0	29	46	15	1	1	0	0	1	0	500	8	2500	35	0.21
5	-0.06	-0.046	0	0	61	100	13.0	29	44	15	1	1	0	0	1	0	500	8	2500	35	0.21
6	1.51	0.866	1	0	62	132	13.0		52		1	2	0	0	1	0	500	14	1400	25	0.46
7	2.56	0.989	1	1	63	162	13.0	29	41	10	1	2	0	0	1	0	500	13	2500	32	0.30
8	-1.03	-0.695	0	0	70	179	7.0	20	36	17	1	1	0	0	0	0	258	5	2300	25	0.15
9	0.78	0.561	0	0	70	179	10.5	20	43	22	1	1	0	0	0	0	258	5	2300	25	0.15
10	-1.85	-0.934	1	0	74	168	7.0		65		1	1	0	0	1	0	256				
11	2.84	0.995	0	0	75	156	12.0		64		3	1	1	1	0	0	762		10800		0.07
12	-0.73	-0.532	1	0	72	88	9.0		53		1	1	0	0	1	0		6		24	0.25
13	3.17	0.998	1	1	69	71	13.0				1	3	0	0	1	1	2400	125		900	0.14
14	2.95	0.996	1	1	69	71	13.0		95		1	3	0	0	1	1	1550	125		350	0.36
15	0.87	0.609	0	0	67	48	7.5		70		2	1	0	0	1	0	1000			55	
16	0.55	0.42[illegible]	0	0	74	1000	9.0		49		1	1	0	0	1	1	174	10	1000	45	0.20
17	-0.39	-0.300	1	1	74	84	13.0		60		4		1	1	0	1	3400	60		1800	0.03
18	-0.12	-0.093	1	0	69	40	13.0	38	60	22	1	1	0	0	1	0	506	10		23	0.43
19	0.04	0.034	0	0	75	30	13.0		27		1	1	0	0	1	1	304		9000		0.34
20	0.82	0.583	1	1	73	57	13.0		76		1	1	0	0	1	1	2365	30		300	0.10
21	-1.25	-0.789	1	1	72	13	3.0		58		9		1	1	0	0	4400		10250		0.43
22	2.88	0.995	0	0	65	75	8.0	32	69	32	1	1	0	0	0	0	694	12	2000	22	0.45
23	0.55	0.418	0	0	77	38	10.0		48		1	1	0	0	1	0	364			110	
24	1.14	0.740	0	0	77	42	10.0		42		1	1	0	0	1	0	269			110	
25	-0.79	-0.570	0	0	76	187	3.0	35	43	09	1	1	1	0	0	0	174	2	1134		0.15
26	-0.13	-0.104	0	0	76	196	4.0	35	53	18	1	1	1	0	0	0	169	2	934		0.18
27	-0.13	-0.106	0	0	76	199	5.0	40	53	13	1	1	1	0	0	0	144	2	650		0.22
28	1.52	0.871	1	0	73	88	13.0		66		4	1	0	0	0	0	350		3500	50	0.10
29	-0.23	-0.181	0	0	73	43	10.0	28	42	15	1	1	0	0	1	0	543		1725		0.31
30	1.02	0.691	1	1	62	132	11.0		80		1	1	0	0	1	1	463	8	2900	28	0.22
31	1.76	0.891	0	0	75	1[illegible]	13.0		55		1	1	0	0	0	0		8			
32	1.24	0.755	0	0	75	12	13.0		55		1	1	0	0	0	0		8			
33	-0.08	-0.067	0	0	72	107	12.5		53		1	1	0	0	1	0	478	10	2500	35	0.24
34	1.79	0.914	1	0	67	24	13.0		42		1	1	0	0	1	0	2575	44		61	0.72
35	0.79	0.563	1	0	67	24	13.0		38		1	1	0	0	1	0	2565	38		57	0.67
36	1.21	0.762	1	0	67	24	13.0		40		1	1	0	0	1	0	3075	57		66	0.86
37	0.13	0.105	0	0	68	24	13.0		34		1	1	0	0	0	0	348				
38	1.19	0.765	0	0	74	94	12.5		55		3	1	1	0	0	0	822	15		165	0.11
39	1.66	0.899	0	0	74	97	12.5		56		3	1	1	0	0	0	1252	25		155	0.16
40	-0.79	-0.460	1	0	72	96	6.0		42		1	2	0	0	0	0	140	5	67	5	1.55
41	-2.42	-0.863	0	0	71	4	13.0		62		3		1	1	1	0	1478				
42	-1.97	-0.856	0	0	71	5	13.0		67		2		1	1	1	0	1394				
43	2.27	0.892	0	0	71	5	13.0		66		2		1	1	1	0	1731				
44	-1.06	-0.705	1	1	73	37	13.0		71		4	6	1	0	0	0	3015			3850	0.06
45	2.44	0.980	0	0	73	40	13.0				1	1	0	0	0	0		24		96	0.25
46	1.10	0.727	1	0	67	36	9.0	33	63	25	1	1	0	0	0	0	26		1000	15	0.03
47	1.97	0.948	1	0	67	36	9.0	33	67	25	1	1	0	0	0	0	586		1000	15	0.59
48	2.82	0.993	0	0	74	51	10.5	40	67	23	1	1	0	0	1	0	1100	9		225	0.04
49	1.65	0.895	0	0	74	54	10.5	34	52	16	1	1	0	0	1	0	890	9		225	0.04
50	1.16	0.752	0	0	71	322	13.0		69		1	1	0	0	0	0	490	10		115	0.09

TABLE 21 (continued)

	Variable Numbers																				
Source	1	2	3	4	5	6	7	9	10	11	12	13	14	15	16	17	20	21	22	23	24
51	2.04	0.957	1	0	76	116	9.5		61		3	1	0	0	1	0					
52	2.23	0.970	1	0	74	40	13.0	44	68	20	1	1	0	0	1	1	343			250	
53	-0.19	-0.147	0	0	76	59	13.0	47	76	29	1	1	0	0	1	0	2150	40		350	0.11
54	0.10	0.082	0	0	70	55	13.0	41	55	14	3	1	0	0	1	0	1200	15		135	0.11
55	0.33	0.256	0	0	73	58	4.0	54	77	22	1	1	0	0	1	1	550				
56	-0.16	-0.130	0	0	73	58	4.0	54	76	22	1	1	0	0	1	1	450				
57	7.09	1.000	0	0	67	10	13.0		55		1	2	0	0	1	0	800	20		150	0.13
58	0.68	0.502	0	0	70	72	13.0	24	50	25	1	1	0	0	0	1	2709	50	12380	150	0.28
59	2.48	0.977	0	0	72	21	13.0		63		2	1	0	0	0	0	180				
60	-0.04	-0.033	0	0	72	59	7.0		60		1	1	0	0	1	0	69		400		0.17
61	0.00	0.000	0	0	76	60	5.0		79		1	1	0	0	0	0	48		940		0.05
62	0.09	0.074	0	0	70	71	13.0	41	53	11	1	1	0	0	1	0	1635		2925		0.56
63	-1.82	-0.918	0	0	74	26	5.0		79		5	1	1	0	0	0	47		574		0.08
64	1.22	0.764	0	0	74	26	5.0		64		5	1	1	0	0	0	47		139		0.34
65	1.05	0.705	1	1	74	33	13.0	35	61	30	1	1	0	0	0	0	910	10	2600	55	0.27
66	-0.94	-0.643	0	0	71	30	13.0		39		1	1	0	0	1	0	478	5	2500	35	0.17
67	1.92	0.940	0	0	75	64	9.0		57		1	1	0	0	1	0		20		50	0.40
68	2.46	0.983	0	0	75	64	9.0		58		1	1	0	0	1	0		20		50	0.40
69	1.83	0.932	0	0	67	184	4.0		43		1	4	0	0	1	0	690	40	1200	80	0.54
70	-0.58	-0.438	0	0	73	88	8.0		56		1	1	0	0	0	0	192		535		0.35
71	0.34	0.268	0	0	73	73	13.0		68		1	1	0	0	0	0	192		535		0.35
72	4.62	1.000	0	0	76	58	13.0		72		1	1	0	0	0	0	271	3	2550	20	0.13
73	0.00	0.000	0	0	73	76	13.0		58		2	1	0	0	0	0					
74	0.49	0.377	0	0	66	48	13.0				1	1	1	0	1	0	378		1775		0.21
75	0.29	0.227	0	0	66	48	13.0				1	1	1	0	1	0	355		2180		0.16
76	1.08	0.690	0	0	70	10	5.0	62	78	14	1	1	0	0	1	1		80		240	0.33
77	4.92	1.000	0	0	75	30	13.0		22		8	1	0	0	0	0	90	1	800	4	0.22
78	2.06	0.960	1	0	73	54	11.0		51		1	1	0	0	0	0	207				
79	2.68	0.991	1	1	68	44	4.0		48		1	1	0	0	1	0		30		92	0.33
80	2.88	0.995	0	0	70	80	4.0		58		1	1	0	0	0	0	260			15	
81	-0.07	-0.053	0	0	77	52	10.0		59		1	1	0	0	0	0	200				
82	1.09	0.723	0	0	75	96	8.0		69		1	1	1	0	0	0	220		2300		0.10
83	-0.28	-0.221	0	0	75	96	8.0		51		1	1	1	0	0	0	224		2300		0.10
84	0.58	0.440	0	0	75	96	8.0		44		1	1	1	0	0	0	228		2300		0.10
85	0.64	0.476	0	0	67	52	13.0		71		1	1	0	0	1	0		9	1000	7	1.25
86	1.78	0.921	0	0	72	80	13.0		55		1	1	1	0	0	0	126	4	1022	35	0.12
87	0.39	0.298	0	0	66	16	6.0		54		1	1	0	0	0	0	1575				
88	0.46	0.348	0	0	66	16	6.0		49		1	1	0	0	0	0	325				
89	2.54	0.988	0	0	74	136	13.0		67		1	2	0	0	1	0	1334	60		2460	0.02
90	0.65	0.458	0	0	70	8	5.0		54		1	1	0	0	0	0	130	1	500	4	0.26
91	0.63	0.448	0	0	70	8	5.0		57		1	1	0	0	0	0	130	1	500	4	0.26
92	-0.27	-0.211	0	0	76	141	13.0		53		5		1	0	0	0	4130			3600	
93	-0.83	-0.591	1	0	70	65	9.0		59		1	1	0	0	0	0	457	5			
94	-0.90	-0.628	0	0	75	136	9.0	42	56	16	1	1	1	0	1	0	372	5	3000	35	0.12
95	-1.41	-0.823	0	0	69	18	13.0		66		1		1	1	1	0					
96	2.03	0.940	0	0	69	18	13.0		68		1		1	1	1	0					
97	0.20	0.158	1	0	70	28	8.0				1	1	0	0	0	0	500		1100		0.45
98	1.98	0.951	0	0	76	289	11.5		34		1	1	0	0	1	0	650			97	
99	2.58	0.988	0	0	72	65	13.0	16	66	43	1		0	1	1	0	760				
100*	2.06	0.959	0	0	75	120	13.0		49		1	1	0	0	1	0	478	8	2500	20	0.30

* This data set was inadvertently omitted from the analysis.

TABLE 22

RAW DATA FOR VARIABLES 25-49

	Variable Numbers																								
Source	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
1	0	1	0	1	2	6	100	0	0	1	3	18	5	1	0	0	0	0	0	0	1	1	0	1	1
2	0	0	1	1	1	4			0	0	1	0	6	0	1	0	0	0	0	0	0	0	0	0	0
3	1	0	0	1	1	8		0	1	0	3	33	6	0	1	0	0	0	0	0	0	0	0	0	0
4	0	0	1						0	0	3		6	0	1	1	1	0	0	0	0	0	0	0	0
5	0	0	1						0	0	3		6	0	1	1	0	0	0	0	0	0	0	0	0
6	1	0	0						0	0	3	0	6	0	1	0	0	0	0	0	0	0	0	0	0
7	0	0	1						0	0	3	0	7	0	0	1	1	0	0	0	0	0	0	0	0
8	1	0	0	1	1	4		4	1	0	3	0	6	0	0	1	1	0	0	0	0	0	0	0	0
9	1	0	0	1	1	4		4	1	0	3	0	6	0	0	1	1	0	0	0	0	0	0	0	0
10	1	0	0	1	1	8	78	0	0	0	3	12	6	1	1	0	0	0	0	1	0	1	1	1	1
11	0	0	1	1	1	10	76	0	0	0	4	0	6	0	1	0	0	0	0	1	0	0	0	1	0
12	1	0	0						0	0	3	0	8	0	0	1		1	0	0	0	1	0	1	0
13	0	0	1	1	2	12		25	0	0	3	9	4	1	0	0	0	0	0	0	0	1	0		1
14	0	0	1	0	1	6		100	0	0	3	9	4	1	0	0	0	0	0	0	1	1	0		1
15	0	0	1	0	1	6			0	0	2	23	5	0	1	0	0	0	0	0	0	1	0	1	0
16	0	0	1	0	1	3	50	0	0	0	4	44	6	0	0	0	1	0	0	0	0	1	0	0	0
17	1	0	0	1	7	9		16	0	1	3		6	1	0	0	0	0	1	1	0	1	1	1	1
18	1	0	0	1	1	7	29	0	1	0	3	0	5	0	0	0	0	0	0	0	0	1	1	0	0
19	0	1	0	1	1	4	7	0	1	0	3	25	6	0	0	1	0	0	0	0	0	1	1	0	0
20	0	1	0	0	2	12		0	0	0	3		7	0	0	0	1	0	0	0	1	1	0		1
21	0	0	1	1	2	13	40	27	0	1	4	0	7	0	0	0	0	1	0	0	1	1	0	1	1
22	1	0	0	0	1	7	0	0	1	0	3	27	6	0	0	1	1	0	0	0	0	0	0	0	0
23	0	1	0	1	1	5			0	0	3	8	5	0	0	0	0	0	0	0	0	1	0	1	0
24	0	1	0	1	1	4			0	0	3	8	5	0	0	0	0	0	0	0	0	1	0	1	0
25	1	0	0	1	4	5	0	0	1	1	4	7	7	0	0	0	0	0	0	0	0	0	0	0	0
26	1	0	0	1	4	4	0	0	1	1	4	3	7	0	0	0	0	0	0	0	0	0	0	0	0
27	1	0	0	1	3	3	0	0	1	1	4	1	7	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	1	1	4	3	100	0	0	0	3	0	3	0	0	0	0	0	1	0	0	0	0	1	0
29	1	0	0	1	3	3	44	0	1	0	3	11	6	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	1	1	1	4	29	0	0	0	3	18	6	0	1	0	1	0	0	0	0	0	0	0	0
31	0	1	0	0	1	3	80	0	0	1	4	27	6	1	0	0	1	1	0	0	0	1	0	1	0
32	0	1	0	0	1	4	80	0	0	1	4	27	6	1	0	0	1	1	0	1	0	1	0	1	0
33	1	0	0	1	1	8	25	0	0	0	3	43	7	0	0	1	0	0	0	0	0	0	0	0	0
34	0	1	0	0	3	5	64	0	0	0	2	0	6	0	0	0	0	1	0	1	1	1	0	1	0
35	0	1	0	0	3	5	64	0	0	0	2	0	6	0	0	0	0	1	0	1	1	1	0	1	0
36	0	1	0	0	3	5	64	0	0	0	2	0	6	0	0	0	0	1	0	1	1	1	0	1	0
37	0	0	1	1	1	1		0	0	0	3	8	5	0	0	0	0	0	0	0	0	0	0	0	0
38	0	1	0	0	1	12	84	0	0	1	4	28	8	0	1	1	0	0	0	0	0	0	0	1	0
39	0	1	0	0	2	10	84	0	0	1	4	28	8	0	1	1	0	0	0	0	0	0	0	1	0
40	1	0	0	1	1	4	0	0	0	0	4	0	5	0	0	0	0	0	0	0	[illegible]	0	0	1	0
41	1	0	0	1	5	4		0	0	1	3	9	5	1	0	0	0	0	1	1	0	1	1	1	1
42	1	0	0	1	2	8		12	0	1	3	9	5	1	0	0	0	0	1	1	0	1	1	1	1
43	1	0	0	1	2	12		6	0	1	3	9	5	1	0	0	1	0	0	1	0	1	1	1	1
44	1	0	0	1	5	8		0	0	1	3	55	5	1	1	1	0	0	0	0	0	1	1	1	1
45	0	0	1						0	0	3	15	5	0	0	0		1	1	1	1	1	1	1	0
46	0	0	1	0	1	2	0	0	1	0	3	14	6	0	1	0	1	0	0	0	0	0	0	0	0
47	0	0	1	0	1	7	0	0	1	0	3	14	6	0	1	0	1	0	0	0	0	0	0	0	0
48	1	0	0	1	1	5		0	1	0	3		6	0	0	0	1	1	0	1	0	1	1	0	1
49	1	0	0	1	1	5		0	1	0	3		6	0	0	0	1	1	0	1	0	1	1	0	1
50	1	0	0	1	1	5			0	0	3	9	7	0	1	0	0	1	1	1	1	1	1	1	0

TABLE 22 (continued)

	Variable Numbers																								
Source	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
51	1	0	0						0	0	3	1	6	0	0	0		0	0	0	0	1	1	1	0
52	1	0	0	1	1	6		0	0	0	3	0	8	1	0	0	1	0	1	1	0	1	1		1
53	0	1	0	0	2	18	43	0	1	0	3	42	8	0	0	1	1	0	0	0	0	0	0	1	0
54	1	0	0	1	1	9		14	1	0	3		5	0	0	0	0	0	0	0	0	1	0	0	1
55	1	0	0						0	0	3	0	6	0	0	0		0	0	0	0	1	0	1	0
56	1	0	0						0	0	3	0	6	0	0	0		0	0	0	0	1	0	1	0
57	1	0	0	1	1	6	15	0	1	0	3	0	5	0	0	0	1	0	1	1	0	1	1	1	0
58	0	0	1	1	3	16		10	1	0	3	0	6	0	0	0	0	0	0	0	0	0	0	0	0
59	0	0	1	0	1	4	100	100	0	1	3	38	5	0	0	0	1	0	0	0	0	0	0	1	0
60	1	0	0	1	1	5	50	0	0	0	4	0	6	0	1	0	0	0	0	0	0	0	0	0	0
61	0	0	1	0	1	3	0	0	0	0	3	0	8	1	1	1	0	0	0	0	0	0	0	0	0
62	1	0	0	1	1	17	0	0	1	0	3	0	7	0	0	1	0	0	1	1	0	0	0	0	0
63	1	0	0	0	1	5	0	0	0	0	3	0	6	0	0	0	0	0	0	0	0	1	0	1	0
64	1	0	0	0	1	5	0	0	0	0	3	0	6	0	0	0	0	0	0	0	0	1	0	1	0
65	0	1	0	0	1	6	72	0	1	1	4	45	6	0	0	0	0	0	0	0	1	1	0	1	0
66	1	0	0	1	1	8	24	0	0	0	3		7	0	0	1	0	0	0	0	0	0	0	0	0
67	1	0	0						0	0	3	0	9	0	0	0		1	1	1	0	1	0	0	0
68	1	0	0						0	0	3	0	9	0	0	0		1	1	1	0	1	0	0	0
69	1	0	0	1	1	10	30	7	1	0	4	20	5	0	0	0	0	0	1	1	0	0	0	0	0
70	0	1	0	0	1	1	25	0	0	0	3	0	6	0	0	1	0	0	0	1	1	1	0	1	0
71	0	1	0	0	1	1	25	0	0	0	3	0	6	0	0	1	0	0	0	1	1	1	0	1	0
72	0	0	1	0	1	14	16	40	0	0	3	0	6	1	0	0	0	1	0	1	0	1	0	0	0
73	0	0	1						0	0	3	0	5	0	0	0		0		0	0	0	0	0	0
74	1	0	0	1	1	3	0	0	0	0	3	20	5	0	0	0	0	0	0	0	0	0	0	0	0
75	1	0	0	1	1	3	0	0	0	0	3	20	5	0	0	0	0	0	0	0	0	0	0	0	0
76	0	1	0						0	0	3	19	7	0	1	1	1	1	0	0	1	1	0	1	1
77	0	0	1						0	0	3	0	5	0	1	0	0	0	0	0	0	0	0	0	0
78	1	0	0	1	1	4			0	0	3	9	5	0	0	1	0	0	0	0	0	1	0	1	0
79	0	0	1						0	0	3	0	7	0	0	1	1	1	0	0	0	1	0	1	0
80	1	0	0	1	1	3	80	13	0	0	4	0	5	0	1	0	0	1	1	1	1	1	1	1	0
81	1	0	0						0	0	3	0	6	0	0	0	0	0	0	0	0	0	0	0	0
82	0	0	1	0	1	10	0	9	0	0	4	0	5	0	0	0	0	0	0	0	0	0	0	0	0
83	1	0	0	1	1	5	0	3	0	0	4	0	5	0	0	0	0	0	0	0	0	0	0	0	0
84	0	0	1	1	1	1	0	25	0	0	4	0	5	0	0	0	0	0	0	0	0	0	0	0	0
85	0	1	0						0	0	3	0	5	0	0	0		1	1	0	1	0	0	0	0
86	0	0	1	1	1	3	35	0	0	0	4	0	5	0	1	0	0	0	0	0	0	0	0	0	0
87	1	0	0	1	1	4		0	0	0	4		5	0	0	0	0	0	0	1	1	1	1	1	1
88	1	0	0	1	1	7		0	0	0	4		5	0	0	0	0	0	0	1	1	1	1	1	1
89	1	0	0	1	3	8		0	0	0	3	2	6	0	0	0	0	0	0	0	0	1	1	1	1
90	1	0	0	0	1	3	0		0	1	4	0	5	0	0	0	0	0	1	0	0	0	0	0	0
91	1	0	0	1	1	3	0		0	1	4	0	5	0	0	0	0	0	1	0	0	0	0	0	0
92	1	0	0	1	8	5		11	0	1	3	65	6	0	1	0	0	0	0	0	0	1	1		1
93	1	0	0	1	1	8		13	0	0	3		8	1	1	0	0	0	0	0	0	1	0	1	0
94	1	0	0	1	1	7	60	0	0	0	3	19	4	0	1	0	1	0	0	1	0	0	0	0	0
95	1	0	0						0	0	3		5	0	0	0		0				1	0	1	0
96	1	0	0						0	0	3		5	0	0	0		0				1	0	1	0
97	1	0	0						0	0	3	0	6	0	0	0	0	0	0	0	0	0	0	0	0
98	1	0	0						0	0	4	0	5	0	0	0	1	0			0	0	0	0	0
99	0	0	1						0	0	3		5	1	1	1		1	0	0	0	0	0	0	0
100 *	1	0	0	1	1	8	25	0	0	0	4	0	7	0	0	0	0	0	0	0	0	0	0	0	0

* This data set was inadvertently omitted from the analysis.

TABLE 23

RAW DATA FOR VARIABLES 50-65

	Variable Numbers															
Source	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65
1	0.80	1.13	0.21	2.4	73	74	26		23	76	0	0	59	18	23	0
2	0.68		0.22	3.1	7	71	29		7	50	0	0	100	0	0	0
3	1.00	1.00	0.42	1.4	13	46	46	0	20	39	0	0	100	0	0	0
4																
5																
6																
7																
8	0.62		0.28	1.6	8	100	0		8	50	1	100	0	0	0	0
9	0.93		0.28	1.6	8	100	0		8	50	1	100	0	0	0	0
10	0.93	0.92	0.19	1.9	10	50	50	60	3	77	0	0	0	0	100	0
11	0.92	1.06	0.26	1.4	31	55	45	0	12	72	0	0	19	0	81	0
12																
13	1.00		0.20	1.5	45	67	33		79	36	0	0	100	0	0	0
14	1.12		0.20	1.2	37	59	41		22	63	0	0	70	30	0	0
15	0.96		0.24	1.5	23	48	48		9	72	0	0	43	57	0	0
16	1.09	0.98	0.35	2.1	3	100	0	0	3	50	1	100	0	0	0	0
17	1.00		0.19	2.6	112	80	20		81	58	0	51	41	0	8	0
18	1.00	1.20	0.18	2.8	33	36	36	0	13	72	0	0	24	6	52	18
19	1.00	2.06	0.21	3.9	5	100	0	60	4	56	1	100	0	0	0	0
20	1.04		0.24	1.1	34	79	21		43	44	0	44	12	44	0	0
21	0.37	0.41	0.31	1.4	121	46	46	68	90	57	0	56	19	0	25	0
22	0.71	0.62	0.14	2.0	30	63	37	0	24	56	0	27	47	0	27	0
23	0.80		0.28	2.1	5	100	0		15	25	1	100	0	0	0	0
24	0.77		0.23	2.2	4	100	0		6	40	1	100	0	0	0	0
25	0.75	0.70	0.27	2.4	19	95	5	32	3	86	0	84	16	0	0	0
26	0.56	0.56	0.23	2.3	16	94	6	56	1	94	0	69	31	0	0	0
27	0.67	0.64	0.30	2.7	16	50	50	56	3	84	0	19	81	0	0	0
28	1.00		0.30	2.6	18	100	0		1	95	1	100	0	0	0	0
29	0.95	1.00	0.33	1.1	10	100	0	20	9	53	1	100	0	0	0	0
30	1.00	1.30	0.14	2.9	10	10	10	0	13	43	0	0	0	0	0	100
31					20	15	15	0	3	87	0	0	0	0	0	100
32					15	40	40	0	1	94	0	0	0	0	0	100
33	0.96	0.96	0.42	1.4	13	46	46	0	20	39	0	0	100	0	0	0
34	1.73		0.35	1.1	105	36	36	0	68	61	0	0	53	0	25	22
35	1.67		0.36	0.7	111	33	33	0	75	60	0	0	35	0	65	0
36	1.69		0.35	1.1	107	37	37	0	36	75	0	0	44	0	49	7
37	1.59		0.26	2.8	1	0	0		8	11	1	100	0	0	0	0
38	0.96		0.27	1.5	21	95	5	0	40	34	0	57	43	0	0	0
39	0.96		0.27	1.4	42	90	10	0	49	46	0	57	43	0	0	0
40	0.55	0.46	0.29	1.8	1	100	0	0	18	5	1	100	0	0	0	0
41	1.04		0.30	2.2	35	77	23		30	54	0	34	66	0	0	0
42	1.08		0.29	2.6	58	67	33		20	74	0	0	52	16	33	0
43	1.08		0.27	1.9	32	100	0		19	63	1	100	0	0	0	0
44	1.00		0.13	4.0	66	67	33		103	39	0	39	36	0	11	14
45																
46		0.80			2	100	0	100	0	100	1	100	0	0	0	0
47	0.74	0.80	0.31	1.6	13	100	0	23	19	41	1	100	0	0	0	0
48	0.81		0.23	1.7	36	77	23		27	57	0	8	67	25	0	0
49	1.64		0.20	1.3	30	70	30		34	47	0	10	50	40	0	0
50	1.44	1.48	0.31	1.1	16	44	44	0	10	62	0	0	0	100	0	0

TABLE 23 (continued)

	Variable Numbers															
Source	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65
51																
52	1.53		0.23	2.0	10	20	20		7	59	0	0	0	0	0	100
53	1.06	1.20	0.22	1.5	72	86	14	0	52	58	0	33	22	44	0	0
54	1.00		0.19	3.2	45	93	7		18	71	0	58	42	0	0	0
55																
56																
57	1.00	1.00	0.24	1.6	25	60	40	0	24	51	0	0	84	0	0	16
58	1.31	1.00	0.26	2.5	79	59	41	18	78	50	0	24	5	4	61	6
59	1.34		0.25	2.7	14	50	50	0	10	58	0	0	100	0	0	0
60	1.13	0.78	0.42	1.6	4	0	0	0	7	36	1	100	0	0	0	0
61	0.82	0.81	0.19	3.8	5	60	40	40	0	100	0	0	0	0	100	0
62	1.00	1.00	0.18	1.2	36	86	14	0	31	53	0	0	100	0	0	0
63		0.71			5	100	0	20	0	100	1	100	0	0	0	0
64		0.71			5	100	0	20	0	100	1	100	0	0	0	0
65	1.51	1.91	0.30	1.2	12	50	50	50	39	24	0	0	42	58	0	0
66	1.00	1.00	0.42	1.4	13	46	46	0	20	39	0	0	100	0	0	0
67																
68																
69	0.66	0.65	0.32	1.1	24	63	37	25	36	40	0	0	63	0	38	0
70	1.03	1.10	0.22	1.7	2	50	50	0	6	25	0	0	0	100	0	0
71	1.67	1.78	0.22	1.7	2	50	50	0	6	25	0	0	0	100	0	0
72	1.00	1.00	0.27	1.4	19	84	16	63	9	68	0	21	79	0	0	0
73																
74	1.00	1.00	0.19	3.0	9	33	33	67	23	28	0	0	0	0	100	0
75	1.00	1.00	0.19	3.0	5	80	20	60	19	21	0	0	60	0	40	0
76																
77																
78	0.85		0.14	3.5	7	86	14		2	78	0	0	100	0	0	0
79																
80	0.53		0.42	1.5	8	63	37	0	7	53	0	0	0	0	100	0
81																
82	1.13	0.79	0.22	2.6	16	100	0	100	17	48	1	100	0	0	0	0
83	1.16	0.71	0.33	1.6	10	60	40	80	4	71	0	0	0	100	0	0
84	1.07	1.01	0.32	1.4	3	33	33	67	15	17	0	0	0	100	0	0
85																
86	1.27	1.37	0.21	1.9	3	100	0	100	4	43	1	100	0	0	0	0
87	1.01		0.28	0.9	18	94	6		47	28	0	0	0	0	100	0
88	0.78	0.73	0.28	0.9	14	85	15		6	70	0	0	100	0	0	0
89	1.00		0.23	1.6	55	95	5		30	65	0	76	24	0	0	0
90	1.28	1.04	0.37	1.5	2	100	0	50	6	25	1	100	0	0	0	0
91	1.00	1.26	0.33	1.5	4	50	50	0	5	44	0	29	0	71	0	0
92	1.27		0.25	1.7	108	65	35		76	59	0	6	50	0	44	0
93	0.97		0.20	2.1	5	40	40	40	23	18	0	0	0	100	0	0
94	0.69	0.84	0.29	2.1	9	100	0	33	16	27	1	100	0	0	0	0
95																
96																
97																
98																
99																
100*	1.00	1.00	0.42	1.4	13	46	46	0	20	39	0	0	100	0	0	0

* This data set was inadvertently omitted from the analysis.

TABLE 24

RAW DATA FOR CALCULATING DEPENDENT VARIABLES

			Dep. Vars.		AO Group			Control Group		
Source	Ret.	Abl.	1	2	N	Mean	S.D.	N	Mean	S.D.
1			-1.15	-0.746	29	86.99	26.97	34	93.92	20.73
1	14		-0.85	-0.601	29	90.49	34.11	34	97.03	26.95
2			1.37	0.826	62	5.18	1.18	62	4.87	1.34
3			2.08	0.959	40	16.70	5.80	40	14.10	5.40
4			1.91	0.941	50	21.83	4.73	50	19.97	5.02
4	10		2.52	0.987	50	20.31	5.74	50	17.63	4.85
5			-0.06	-0.046	50	19.91	5.34	50	19.97	5.02
5	10		2.13	0.964	50	19.65	4.63	50	17.63	4.85
6			1.51	0.866	66	19.40		66	18.20	
6		5	-0.14	-0.112	22	20.90		22	21.10	
6		3	0.42	0.328	22	19.10		22	18.50	
6		1	2.33	0.979	22	18.30		22	15.00	
7			2.56	0.989	81	19.40		81	17.60	
7		5	0.45	0.344	27	21.10		27	20.60	
7		3	1.97	0.949	27	18.70		27	16.50	
7		1	2.23	0.973	27	18.30		27	15.80	
8			-1.03	-0.695	89	8.36	3.64	90	8.92	3.65
9			0.78	0.561	88	10.59	4.09	91	10.13	3.84
10			-1.85	-0.934	84	32.55		84	33.71	
10	24		-2.81	-0.994	84	35.00		84	36.64	
10		5	0.20	0.156	21	38.71		21	38.48	
10		3	-1.91	-0.942	42	32.79		42	34.36	
10		1	-1.47	-0.858	21	25.90		21	27.62	
11			2.84	0.995	78	23.17	5.48	78	20.58	5.92
12			-0.73	-0.532	44	15.40		44	16.40	
13			3.17	0.998	34	127.90		37	118.00	
14			2.95	0.996	34	97.00		37	94.09	
15			0.87	0.609	24	17.38	4.10	24	16.33	4.30
16			0.55	0.421	500	5.89	2.62	500	5.80	2.51
16		4	0.67	0.498	400	6.32	2.59	400	6.20	2.46
16		1	-0.21	-0.167	100	4.15	1.96	100	4.21	2.05
17			-0.39	-0.300	36	29.96		48	30.33	
18			-0.12	-0.093	20	14.30	3.69	20	14.40	3.59
18	7		-0.73	-0.529	20	13.65	4.28	20	14.20	3.27
19			0.04	0.034	15	7.66	2.95	15	7.62	2.08
19	14		0.46	0.351	15	4.00	1.89	15	3.60	2.79
19		5	-0.26	-0.200	9	8.32	2.80	6	8.67	2.16
19		1	-0.20	-0.153	6	6.67	3.13	9	6.92	1.82
20			0.82	0.583	29	34.84		28	33.88	
20	21		-0.68	-0.499	29	32.88		28	33.73	
20		5	-1.30	-0.792	14	36.60		9	39.07	
20		3	-0.36	-0.275	9	33.34		9	33.89	
20		1	3.66	0.997	6	35.61		10	27.64	
21			-1.25	-0.789	6	16.73		7	18.16	
22			2.88	0.995	38	37.82	6.01	37	33.27	7.08
22	21		2.02	0.953	38	29.32	7.63	37	25.94	6.16
22	63		1.38	0.828	38	27.29	7.58	37	24.92	6.36
22		4	1.24	0.779	21	39.67	5.24	17	37.29	6.56
22		2	2.90	0.994	17	35.53	6.25	20	29.85	5.66
23			0.55	0.418	21	11.80	5.07	17	11.00	3.43
24			1.14	0.740	22	10.86	4.57	20	9.35	3.93
25			-0.79	-0.570	92	14.13	5.91	95	14.82	6.03
26			-0.13	-0.104	98	17.28	6.07	98	17.40	6.74
27			-0.13	-0.106	97	18.36	4.89	102	18.47	6.58
28			1.52	0.871	44	15.81		44	14.54	
29			-0.23	-0.181	23	14.17	5.37	18	14.56	5.48
30			1.02	0.691	66	28.30	11.98	66	26.30	10.44
30	7		3.02	0.997	132	20.60	8.06	132	17.50	8.63
31			1.76	0.891	6	5.77	0.41	6	5.21	0.66
32			1.24	0.755	6	5.79	0.94	6	5.21	0.66
33			-0.08	-0.067	55	17.07	5.05	52	17.15	4.75
33	21		-0.23	-0.183	30	13.30	4.25	31	13.55	4.15
34			1.79	0.914	12	6.70		12	5.00	
34		5	2.86	0.991	6	9.33		6	5.50	
34		1	-0.32	-0.249	6	4.07		6	4.50	
35			0.79	0.563	12	5.75		12	5.00	
35		5	0.87	0.608	6	6.67		6	5.50	
35		1	0.25	0.192	6	4.83		6	4.50	
36			1.21	0.762	12	6.15		12	5.00	
36		5	1.87	0.925	6	8.00		6	5.50	
36		1	-0.15	-0.117	6	4.30		6	4.50	
37			0.13	0.105	13	4.08	1.32	11	4.00	1.61
38			1.19	0.765	50	14.24	4.19	44	13.11	4.98
38	7		2.24	0.973	50	13.88	4.67	44	11.66	4.92
38		4	1.26	0.788	25	16.16	3.38	23	14.65	4.82
38		2	0.69	0.505	25	12.32	4.09	21	11.43	4.69
39			1.66	0.899	53	14.68	4.36	44	13.11	4.98
39	7		2.60	0.989	53	14.13	4.44	44	11.66	4.92
39		4	0.58	0.438	28	15.43	4.68	23	14.65	4.82
39		2	1.90	0.936	25	13.84	3.90	21	11.43	4.69
40			-0.79	-0.460	48	7.67		49	8.03	
41			-2.42	-0.863	2	59.05	0.74	2	64.46	3.08

TABLE 24 (continued)

			Dep. Vars.		AO Group			Control Group		
Source	Ret.	Abl.	1	2	N	Mean	S.D.	N	Mean	S.D.
42			-1.97	-0.856	3	64.86	3.31	2	71.07	3.74
43			2.27	0.892	2	68.45	1.46	3	64.16	2.32
44			-1.06	-0.705	18	237.10		19	260.70	
45			2.44	0.980	20	14.25	5.76	20	10.30	4.41
46			1.10	0.727	24	7.88		12	6.92	
46		5	0.14	0.110	12	8.34		6	8.17	
46		3	1.43	0.842	12	7.42		6	5.67	
47			1.97	0.948	24	8.63		12	6.92	
47		5	1.63	0.893	12	10.17		6	8.17	
47		3	1.42	0.840	12	7.09		6	5.67	
48			2.82	0.993	27	14.20	2.10	24	12.50	2.20
48	21		1.66	0.896	25	13.20	1.80	22	12.10	2.70
49			1.65	0.8[illegible]5	27	11.00	2.40	27	9.90	2.50
49	21		1.21	0.[illegible]6	23	10.10	2.40	22	9.20	2.60
50			1.16	0.752	166	14.01	2.69	156	13.65	2.89
51			2.04	0.957	56	19.15		60	17.59	
52			2.23	0.970	20	28.40		20	25.65	
52		4	1.66	0.903	10	31.00		10	28.10	
52		2	1.49	0.864	10	25.80		10	23.20	
53			-0.19	-0.147	31	31.87	3.96	28	32.11	5.85
53	7		-1.33	-0.810	28	30.61	5.23	28	32.21	4.85
53		5	1.01	0.677	10	34.90	2.51	11	33.18	4.79
53		3	-0.72	-0.518	11	31.91	3.42	9	33.34	5.43
53		1	-0.17	-0.136	10	28.80	3.52	8	29.25	7.24
54			0.10	0.082	28	36.03	6.75	27	35.85	6.20
54		4	0.34	0.266	14	40.07	5.46	14	39.36	5.46
54		2	-0.04	-0.032	14	32.00	5.46	13	32.08	4.61
55			0.33	0.256	29	23.16	3.61	29	22.86	3.36
55	7		-0.81	-0.580	29	20.70	4.55	29	21.63	4.16
56			-0.16	-0.130	29	22.72	3.10	29	22.86	3.36
56	7		-0.93	-0.643	29	20.65	3.87	29	21.63	4.16
57			7.09	1.000	5	12.60	0.59	5	9.91	0.61
57	21		8.12	0.999	3	10.20	0.26	3	7.64	0.48
58			0.68	0.502	36	25.89	7.47	36	24.64	8.08
59			2.48	0.977	13	11.22	4.21	8	7.00	2.93
60			-0.04	-0.033	30	19.23	4.79	29	19.28	4.39
60		5	0.85	0.590	8	24.13	3.23	9	23.00	2.24
60		3	0.15	0.117	17	18.41	3.47	14	18.21	4.02
60		1	-0.77	-0.540	5	14.20	4.15	6	16.17	4.26
61			0.00	0.000	30	11.00	2.70	30	11.00	2.00
61		5	-0.66	-0.483	8	12.40	1.10	8	12.80	1.30
61		3	0.00	0.000	14	10.90	2.70	14	10.90	2.00
61		1	0.31	0.240	8	9.90	4.40	8	9.30	3.20
62			0.09	0.074	36	18.46	3.71	35	18.37	4.36
62	7		0.32	0.248	33	17.33	4.15	34	17.03	3.58
63			-1.82	-0.918	13	14.85	3.08	13	16.77	2.24
64			1.22	0.764	13	13.46	2.37	13	12.23	2.77
65			1.05	0.705	16	11.06		17	10.66	
66			-0.94	-0.643	13	15.15	5.40	17	17.29	6.75
66	7		-0.52	-0.393	11	15.55	3.50	14	16.71	6.66
67			1.92	0.940	32	18.13	3.60	32	16.16	4.56
67		4	1.42	0.834	16	20.38	3.05	16	18.44	4.53
67		2	1.88	0.931	16	15.88	2.58	16	13.88	3.36
68			2.46	0.983	32	18.81	4.08	32	16.16	4.56
68		4	2.42	0.978	16	21.81	3.25	16	18.44	4.53
68		2	1.94	0.938	16	15.81	2.14	16	13.88	3.36
69			1.83	0.932	92	13.41	4.08	92	12.34	3.83
69	14		1.91	0.942	92	13.17	3.90	92	12.02	4.27
70			-0.58	-0.438	44	6.52	2.64	44	6.86	2.84
70	7		0.09	0.068	44	7.43	2.69	44	7.38	2.78
71			0.34	0.268	33	8.33	2.62	40	8.10	3.02
71	7		0.15	0.119	33	9.61	2.14	40	9.53	2.35
71	21		-1.15	-0.746	33	9.30	2.10	40	9.83	1.84
72			4.62	1.000	27	20.41	3.06	31	15.68	4.48
73			0.00	0.000	38	20.30	4.30	38	20.30	3.90
73	7		0.00	0.000	38	19.60	4.30	38	19.60	4.90
73		5	-0.55	-0.414	9	22.80	4.50	12	23.90	4.50
73		3	0.00	0.000	21	19.60	4.40	17	19.60	4.00
73		1	1.86	0.917	8	19.40	4.20	9	16.10	3.10
74			0.49	0.377	24	39.41	6.02	24	38.25	9.89
74	42		-0.59	-0.443	24	26.25	6.27	24	27.33	6.38
74		4	-0.13	-0.102	12	41.83	6.02	12	42.17	6.85
74		2	0.75	0.541	12	37.00	5.17	12	34.33	11.14
75			0.29	0.227	24	37.13	11.36	24	36.16	11.57
75	42		0.12	0.097	24	27.75	6.73	24	27.50	7.43
75		4	0.44	0.339	12	41.00	7.93	12	39.33	10.34
75		2	0.05	0.038	12	33.25	13.19	12	33.00	12.29
76			1.08	0.690	5	19.32	1.53	5	18.33	1.35
76	7		1.35	0.785	5	20.39	1.54	5	19.04	1.63
76	14		0.57	0.416	5	19.46	2.18	5	18.69	2.09
76		4	0.82	0.567	5	20.59	1.06	5	20.10	0.80
76		2	0.44	0.326	5	17.18	1.89	5	16.68	1.73

TABLE 24 (continued)

Source	Ret.	Abl.	Dep. Vars. 1	Dep. Vars. 2	AO Group N	AO Group Mean	AO Group S.D.	Control Group N	Control Group Mean	Control Group S.D.
77			4.92	1.000	15	8.20	2.91	15	3.40	2.41
78			2.06	0.960	27	14.50		27	10.19	
78	7		1.39	0.833	27	10.96		27	8.30	
79			2.68	0.991	22	26.24		22	22.25	
79	45		2.63	0.990	22	27.22		22	22.89	
80			2.88	0.995	40	18.75	3.79	40	16.02	4.64
81			-0.07	-0.053	26	15.81	5.94	26	15.92	6.03
82			1.09	0.723	48	19.55	4.69	48	18.55	4.26
82		5	1.11	0.722	16	22.87	4.77	16	21.18	3.83
82		3	0.73	0.530	16	17.18	3.08	16	16.37	3.18
82		1	0.33	0.254	16	18.62	4.25	16	18.12	4.41
83			-0.28	-0.221	48	16.14	4.33	48	16.42	4.94
83		5	-0.02	-0.014	16	18.62	4.89	16	18.65	4.78
83		3	-0.64	-0.476	16	15.06	5.28	16	16.25	5.15
83		1	0.28	0.222	16	14.75	3.39	16	14.37	4.14
84			0.58	0.440	48	14.41	3.7[illegible]	48	13.99	3.31
84		5	-0.06	-0.045	16	16.25	3.44	16	16.31	2.49
84		3	-0.05	-0.042	16	13.62	3.55	16	13.68	2.88
84		1	1.14	0.736	16	13.37	3.66	16	12.00	3.12
85			0.64	0.476	26	8.00	2.11	26	7.58	2.59
86			1.78	0.921	40	11.60	3.14	40	10.40	2.88
87			0.39	0.298	8	19.57	1.27	8	19.33	1.19
88			0.46	0.348	8	19.71	0.99	8	19.31	2.25
88	56		-0.88	-0.607	8	19.62	1.88	8	20.56	2.36
89			2.54	0.988	68	41.29	4.87	68	38.68	6.92
89	99		2.02	0.955	68	40.25	4.54	68	38.31	6.47
90			0.65	0.458	4	61.70	8.14	4	55.70	16.70
91			0.63	0.448	4	48.10	5.43	4	42.90	15.60
92			-0.27	-0.211	68	18.29	4.04	73	18.50	5.13
92		5	-0.26	-0.205	30	19.27	4.27	38	19.57	5.01
92		2	0.17	0.137	38	17.52	3.73	35	17.34	5.08
93			-0.83	-0.591	28	22.86		37	24.05	
94			-0.90	-0.628	70	13.65	4.87	66	14.40	4.89
94		4	-1.15	-0.745	34	16.38	3.83	31	17.41	3.36
94		2	-0.63	-0.469	36	11.08	4.35	35	11.74	4.49
95			-1.41	-0.823	9	23.33	1.58	9	24.33	1.42
95		5	-0.37	-0.272	3	24.00	1.00	3	24.33	1.16
95		3	-1.32	-0.743	3	22.67	2.52	3	25.00	1.73
95		1	-0.31	-0.226	3	23.33	1.16	3	23.67	1.53
96			2.03	0.940	9	25.66	2.24	9	23.55	2.18
96		5	1.25	0.722	3	27.00	1.00	3	25.33	2.08
96		3	3.02	0.961	3	26.67	1.53	3	24.00	
96		1	1.34	0.749	3	23.33	2.08	3	21.33	1.53
97			0.20	0.158	24			24		
98			1.98	0.951	143	6.38	2.75	146	5.78	2.39
99			2.58	0.988	30	14.66	3.99	35	12.11	3.97
99	37		1.37	0.825	30	11.23	4.65	35	9.69	4.39
100*			2.06	0.959	60	16.62	5.03	60	14.70	5.16
100*	21		2.11	0.963	60	13.30	3.89	60	11.70	4.41

* The data set for this study was inadvertently omitted from the main analysis, but these two data sets were included in the analysis of the retention measure variables.

Appendix E

Intercorrelations for Variables in the Regression and Factor Analysis

The correlation matrix for the variables in the regression and factor analysis is presented in Table 26. Coefficients that are significant at the 0.001, 0.010 and 0.050 alpha levels are marked by @, * and # respectively. The number of cases is given in parentheses below the coefficient for those coefficients that were not based on 77 cases. The variable numbers for the correlation matrix correspond to the numbers in the list of variables in Table 25.

TABLE 25

VARIABLE LIST FOR THE CORRELATION MATRIX

Variable No.	Variable Name
1	t-statistic
2	Probability
5	Date
7	Grade Level
10	Achievement
12	Number of AOs
14	AO During LM
16	Control Intro.
20	AO Length-Words
25	Science
26	Mathematics
27	Other Subjects
28	Concept Type
29	No. of Concepts
30	Attributes
32	Test Ans. in AO
33	Check Alt. Hyp.
34	Equal Time
35	Sampling
37	Quality of Test
38	Wrong Unit
39	Type I Error
40	Type II Error
41	Type of AO
42	Mode for AO
43	Concrete Exp.-AO
44	Diagrams in AO
45	Questions in LM
46	Mode for LM
47	Lab in LM
48	Questions in LM
49	Control of LM
50	AO Reading Level
52	Commonality
53	Prog. Density
54	No. of Moves
56	50% C - 50% E
58	Subconcept Moves
60	All C or All E
61	% C or E
62	% CEC
63	% EC
64	% CE

TABLE 26

INTERCORRELATIONS FOR VARIABLES IN THE REGRESSION AND FACTOR ANALYSIS

Variable Number	1	2	5	7	10	12	14	16	20	25	26	27	28	29	30
1	--														
2	88@	--													
5	-20	-23#	--												
7	26#	26#	-09	--											
10	15 (74)	11 (74)	07 (74)	04 (74)	--										
12	-27#	-32*	20	-11	19 (74)	--									
14	-28#	-30*	29#	-11	07 (74)	45@	--								
16	03	01	-21	33*	01 (74)	-19	-25#	--							
20	-08 (75)	-12 (75)	-05 (75)	31* (75)	05 (72)	50@ (75)	14 (75)	15 (75)	--						
25	-21	-33*	-13	-23#	-12 (74)	-04	17	07	-14 (75)	--					
26	-01	10	24#	29#	-16 (74)	-02	-18	10	22 (75)	-56@	--				
27	25#	29#	-07	-01	30* (74)	07	03	-17	-04 (75)	-63@	-29*	--			
28	-19	-28#	-04	-04	-31* (74)	03	13	21	-01 (75)	54@	-47@	-18	--		
29	-25#	-28#	19	16	-04 (74)	39@	39@	-08	63@ (75)	13	-01	-13	16	--	
30	10	01	03	22	22 (74)	19	06	18	47@ (75)	-03	01	03	-01	08	--
32	25# (69)	18 (69)	00 (69)	11 (69)	30# (66)	08 (69)	-05 (69)	-06 (69)	10 (67)	-23 (69)	-18 (69)	43@ (69)	-18 (69)	-04 (69)	09 (69)
33	10	04	-14	-06	-23# (74)	-23#	-19	07	-08 (75)	21	-10	-15	11	-03	16
34	-22#	-22#	29*	-04	04 (74)	42@	44@	-29*	32* (75)	04	15	-19	-05	46@	03
35	-05	-04	26#	-36@	-13 (74)	04	30*	-48@	-23# (75)	12	-08	-06	07	-12	-02
37	-14	-12	22	-04	03 (74)	00	01	-10	06 (75)	-02	23#	-19	-22	02	28#
38	-07	-18	18	21	37@ (74)	13	05	06	24# (75)	-01	-01	02	-01	19	16
39	00	04	-11	-06	26# (74)	05	10	-11	-07 (75)	-08	-14	23#	01	-02	00
40	-14	-16	10	13	-08 (74)	05	-09	-13	-05 (75)	-01	23#	-21	-15	-10	14
41	29*	25#	-06	14	16 (74)	-20	-21	10	-07 (75)	-05	02	04	-21	-20	01
42	25#	25#	01	08	-08 (74)	03	-18	-01	30* (75)	-15	25#	-06	-19	-01	-01
43	09	04	-11	00	07 (74)	04	-03	03	01 (75)	32*	-22	-16	22	15	02
44	17	08	-08	13	00 (74)	-12	-05	16	16 (75)	16	07	-26#	05	04	09
45	00	04	-18	-03	06 (74)	10	-22	-04	34* (75)	-25#	42@	-11	-25#	-01	-07
46	07	00	12	20	15 (74)	23#	-16	20	38@ (75)	-02	29#	-25#	-10	14	01
47	03	-08	01	16	09 (74)	06	06	16	22 (75)	44@	-21	-31*	38@	29#	02

TABLE 26 (continued)

Variable Number	1	2	5	7	10	12	14	16	20	25	26	27	28	29	30
48	02 (72)	-01 (72)	14 (72)	16 (72)	20 (70)	39@ (72)	03 (72)	-11 (72)	38@ (70)	-17 (72)	44@ (72)	-23 (72)	-21 (72)	22 (72)	08 (72)
49	-11	-17	05	14	29# (74)	36@	10	25#	54@ (75)	22	-14	-12	27#	36*	24#
50	13 (72)	26# (72)	-11 (72)	58@ (72)	-04 (69)	-20 (72)	-16 (72)	10 (72)	17 (72)	-23 (72)	29# (72)	00 (72)	-33* (72)	08 (72)	-11 (72)
52	-04 (72)	01 (72)	-13 (72)	-19 (72)	-40@ (69)	-08 (72)	-09 (72)	02 (72)	-09 (72)	07 (72)	01 (72)	-09 (72)	-02 (72)	-05 (72)	-12 (72)
53	-23 (72)	-23 (72)	18 (72)	06 (72)	12 (69)	11 (72)	21 (72)	-05 (72)	-16 (72)	-01 (72)	-16 (72)	15 (72)	22 (72)	12 (72)	-20 (72)
54	-06	-10	-04	28#	00 (74)	47@	15	16	93@ (75)	-12	21	-06	-04	64@	43@
56	06	-02	-15	09	15 (74)	01	-10	02	22 (75)	-03	04	00	-03	01	05
58	-04	-08	-12	29#	-02 (74)	37@	16	08	89@ (75)	-09	15	-04	03	55@	51@
60	-11	-04	12	-17	-21 (74)	-01	02	-08	-35* (75)	-05	-08	14	-03	-16	-24#
61	-16	-11	24	-21	-18 (74)	13	18	-15	-21 (75)	-01	-07	08	-02	05	-09
62	25#	13	-21	24#	00 (74)	01	-09	28#	20 (75)	12	-12	-03	09	10	29#
63	-11	-08	11	-02	15 (74)	-15	-07	-17	-11 (75)	-08	17	-06	-10	-18	-14
64	-06	-06	-18	-12	02 (74)	02	03	02	19 (75)	06	-07	00	08	05	00

TABLE 26 (continued)

Variable Number	32	33	34	35	37	38	39	40	41	42	43	44	45	46	47
32	--														
33	-17 (69)	--													
34	12 (69)	-08	--												
35	-05 (69)	02	34*	--											
37	-25# (69)	18	11	03	--										
38	23 (69)	-30*	33*	-07	00	--									
39	-12 (69)	-15	-05	-06	20	02	--								
40	-16 (69)	14	-05	-07	39@	-08	02	--							
41	00 (69)	28#	-03	-05	11	04	-03	04	--						
42	04 (69)	-08	02	-09	12	08	-06	-20	13	--					
43	-02 (69)	-02	17	08	-13	15	-08	-12	-07	03	--				
44	-09 (69)	-10	-06	-11	-04	24#	-06	-12	09	45@	41@	--			
45	12 (69)	-21	-03	-06	-01	-06	-11	-06	-18	38@	-02	34*	--		
46	08 (69)	-24#	05	-22	-10	40@	-19	-20	-04	38@	04	41@	44@	--	
47	-09 (69)	01	11	-05	-08	27#	04	-12	06	13	35*	50@	06	52@	--
48	09 (64)	-45@ (72)	26# (72)	-07 (72)	-03 (72)	30# (72)	00 (72)	-03 (72)	-13 (72)	19 (72)	12 (72)	33* (72)	45@ (72)	61@ (72)	27# (72)
49	16 (69)	-15	26#	-06	-13	48@	-12	-21	04	02	09	27#	20	54@	61@
50	05 (64)	-17 (72)	-08 (72)	-27# (72)	02 (72)	01 (72)	-13 (72)	-09 (72)	-01 (72)	24 (72)	04 (72)	25# (72)	25# (72)	23 (72)	08 (72)
52	-09 (64)	-09 (72)	02 (72)	22 (72)	03 (72)	-30# (72)	01 (72)	-19 (72)	-12 (72)	26# (72)	17 (72)	07 (72)	17 (72)	-20 (72)	-15 (72)
53	-02 (64)	00 (72)	13 (72)	-15 (72)	-12 (72)	21 (72)	07 (72)	14 (72)	-06 (72)	-34* (72)	-08 (72)	-35* (72)	-43@ (72)	-08 (72)	06 (72)
54	09 (69)	-03	28#	-28#	09	15	-11	-08	-11	36@	03	21	32*	32*	19
56	25# (69)	-07	10	-13	11	16	06	03	-19	21	09	23	32*	16	06
58	07 (69)	-02	22	-15	08	12	-01	05	-12	18	-02	09	23#	22	18
60	-16 (69)	04	-20	08	-27#	-22	00	-07	16	-24#	-09	-27#	-28#	-22	-19
61	-18 (69)	11	01	18	-10	-23#	-02	-03	12	-27#	-10	-36@	-32*	-24#	-17
62	30# (69)	12	09	-27#	-01	05	-12	13	-14	02	04	10	01	04	04
63	07 (69)	-10	-09	04	09	-04	01	05	-09	03	04	06	31*	14	-05
64	-08 (69)	-13	-13	-03	-03	07	18	-08	-24#	14	01	26#	22	05	21

TABLE 26 (continued)

Variable Number	48	49	50	52	53	54	56	58	60	61	62	63	64
48	--												
49	28# (72)	--											
50	12 (67)	01 (72)	--										
52	-07 (67)	-28# (72)	07 (72)	--									
53	-18 (67)	-03 (72)	-18 (72)	-53@ (72)	--								
54	33# (72)	43@	22 (72)	-04 (72)	-14 (72)	--							
56	16 (72)	05	18 (72)	05 (72)	-14 (72)	23#	--						
58	27# (72)	42@	17 (72)	-09 (72)	-14 (72)	81@	22	--					
60	-18 (72)	-27#	-09 (72)	19 (72)	09 (72)	-37@	-74@	-35*	--				
61	-18 (72)	-15	-21 (72)	11 (72)	14 (72)	-22	-81@	-20	88@	--			
62	-02 (72)	18	-05 (72)	-02 (72)	-07 (72)	23#	36@	23#	-51@	-50@	--		
63	11 (72)	-08	26# (72)	-02 (72)	-24# (72)	-15	43@	-10	-27#	-32*	-20	--	
64	10 (72)	08	-02 (72)	-03 (72)	05 (72)	23#	32*	19	-29*	-37@	-14	-20	--

@ $p \leq 0.001$
* $p \leq 0.010$
# $p \leq 0.050$

Appendix F

Factor Pattern Matrix

The factor loadings for each variable on the six factors are presented in Table 27. The communality for each variable is also given. The first six eigen values for the correlation matrix with communalities on the diagonal were 6.43, 3.79, 3.15, 2.80, 2.60 and 2.50 which accounted for 53.2% of the variance.

TABLE 27

FACTOR PATTERN MATRIX

			Factor Loadings					
Variable		Comm	I	II	III	IV	V	VI
5	Date	77	02	39	-04	10	16	17
7	Grade Level	92	28	-46	-10	08	19	-02
10	Achievement	95	-06	02	-18	12	60	-16
12	Number of AOs	82	51	47	-06	13	16	13
14	AO During LM	71	25	57	10	-13	12	10
16	Control Intro.	90	13	-62	21	-06	08	03
20	AO Length-Words	99	95	-02	-08	21	-04	-05
25	Science	98	-11	09	85	-24	-06	-08
27	Other Subjects	98	-03	-05	-56	-08	26	07
28	Concept Type	95	02	01	62	-30	06	00
29	No. of Concepts	95	65	25	17	02	04	10
30	Attributes	94	48	-10	-06	-17	05	-10
32	Test Ans. in AO	68	03	-02	-28	09	30	-17
33	Check Alt. Hyp.	67	05	-21	14	-43	-22	03
34	Equal Time	95	32	56	08	05	10	-05
35	Sampling	78	-19	58	10	-02	-19	02
37	Quality of Test	73	11	11	-10	-14	-16	-19
38	Wrong Unit	56	09	04	12	23	56	-11
39	Type I Error	74	-07	11	-10	-10	11	-08
40	Type II Error	93	02	-01	-10	-27	-03	-11
41	Type of AO	79	-08	-26	-05	00	06	18
42	Mode for AO	93	13	-10	-05	46	-26	-15
43	Concrete Exp.-AO	68	-05	05	40	13	00	-10
44	Diagrams in AO	84	-03	-19	39	47	-07	-23
45	Questions in AO	90	08	-02	-14	60	-25	-27
46	Mode for LM	87	13	-15	20	70	26	-02
47	Lab in LM	94	08	-09	68	28	26	-03
48	Questions in LM	89	20	19	-01	63	13	-07
49	Control of LM	98	38	-04	38	27	42	00
50	AO Reading Level	94	07	-32	-18	37	-10	-06
52	Commonality	87	-05	11	02	15	-65	03
53	Prog. Density	81	-05	08	04	-36	56	15
54	No. of Moves	97	92	-04	-07	18	-12	-08
56	50% C - 50% E	82	-02	01	-01	06	04	-85
58	Subconcept Moves	95	86	-02	-07	03	-09	-11
60	All C or All E	99	-15	00	-13	06	-16	91
61	% C or E	99	08	19	-11	-05	-16	96
62	% CEC	97	23	-25	10	-27	09	-41
63	% EC	84	-30	09	-11	24	-02	-35
64	% CE	88	05	03	13	07	-01	-27

Appendix G

Advance Organizers and Descriptions of Materials

This appendix contains copies of the advance organizers for the reports that were analyzed for this study. The advance organizers are presented in alphabetical order according to author. The source from which each advance organizer was obtained is identified. If a copy of the advance organizer was not obtained for a report, a description of the procedures followed in the attempt to get it is given. The concept for each advance organizer is identified, and a brief description of the control introduction and learning materials is provided. The instructional moves identified for each advance organizer are listed and they are separated into teaching strategies by / marks. When more than one passage was used as an advance organizer, the instructional moves for each passage are separated by semicolons. Characterization moves and exemplification moves are designated by C and E respectively. Long sequences of C or E moves are designated by a number followed by the letter. For example, 8CE designates eight C moves and one E move. If the advance organizer was excessively long, only a portion was reproduced.

Andreozzi, 1975

Source: dissertation - received from author, 3 Taffy Drive, Seekonk, Mass. 02771; also available on microfilm.

Concepts: linear equations, systems of linear equations, and their solution sets.

Advance Organizers: Six advance organizers were prepared for six days of instruction. The students read the advance organizers and did the exercises before the teacher taught the day's lesson.

Day One

An equation of the form $Ax + By = C$ where A, B, and C are constants and A and B are not both zero, is called a linear equation in the variables x and y. An ordered pair of numbers (x_1, y_1) is said to satisfy the equation if when x is replaced by x_1, and y is replaced with y_1, the equation becomes a true statement.

An equation of the form $Dx + Ey + Fz = G$ where D, E, F and G are constants and D, E, F are not all zero, is called a linear equation in the variables x, y, and z. An ordered triple of numbers (x_1, y_1, z_1) is said to satisfy the equation if when x is replaced by x_1, y is replaced by y_1, and z is replaced by z_1, the equation becomes a true statement.

The solution or solution set of a linear equation in two variables is the set of all ordered pairs of numbers which satisfy the equation. The solution set of a linear equation in three variables is the set of all ordered triples of numbers that satisfy the equation. Solution sets of these equations may contain an unlimited number of members, that is, they may form an infinite set.

Questions:

1. In the linear equation $Ax + By = C$, may both A and B be equal to zero?

2. In the linear equation $Ax + By = C$ could both x and y be equal to zero? That is, could the ordered pair (0,0) be a number of the solution set of the given equation? If yes, state the conditions when it would be true.

3. In a linear equation is four variables, how many ordered - numbers would you think are necessary to satisfy the equation?

Day Two

We have seen that the solution to an equation in two unknowns is the set of all ordered-pairs, each of which make the equation a true statement. For example, the ordered-pair (2,1) is an element of the solution set of the equation $2x - 3y = 1$, other elements are (5,3) and (8,5). The solution set for this equation contains an infinite number of elements. If the equation has three variables, then ordered-triples are selected such that the equation is made into a true statement. The set of all ordered-triples which satisfy the equation is the solution set. That is, $3x + 4y - 5z = 12$ is satisfied by the ordered-triple (2,-1,-2) since $3(2) + 4(-1) - 5(-2) = 12$. Therefore, (2,-1,-2) is an element of the solution set for the equation $2x + 4y - 5z = 12$.

Recall that if each of the variables in the equation is of the first degree, such as $3x + 5y = 12$, the equation is called a linear equation in two unknowns. The equation $5x + 4y - 5z = 12$ is an example of a linear equation in three variables and the equation $2x + 4y + 5z - 6w = 13$ is an example of a linear equation in four variables.

When two or more conditions are placed on the variables of a problem at the same time, these conditions determine a system of equations. Recall the puzzle about a pair of numbers where the conditions were:

(1) the sum of the numbers is 7
(2) multiply the first number by 3 and subtract 1, and you will get the second number.
These conditions placed on the variables result in the system: $x + y = 7$, $3x - 1 = y$.

This system may or may not have a non-empty solution set. If it does, each element in the solution set will make both equations true statements. In general, the common solution of the equations in a system, or the solution set of a system of linear equations, will be the set of all ordered-pairs, ordered-triples, etc., depending upon the numbers of variables in the system, each of which make every equation in the system a true statement.

Questions:
1. Name one element in the solution set of the equation $2x - 3y = 1$.
2. The equation $2x + 4y + 5z - 6w = 13$ is an example of what type equation?
3. For an ordered-triple to belong to the solution set of a system of equations, how many equations must the ordered-triple make true?

Day Three

Recall that the solution to a linear system is the set of all points that make all of the equations in the system true statements. In the case of a system of linear equations in two inknowns, a graph of the equations is one way to help in determining the solution set. This is considered a geometric method. The geometric method, however, does not yield an exact solution and more accurate algebraic methods must be determined.

The algebriac methods are based on the equality statement. The equality statement in mathematics allows one to make perfect substitutions within his mathematical model. If one has the statements $A = B$ and $B = C$, then the statement $A = C$ may be concluded. Functionally, this allows one to introduce into his model new statements, which are generated from the original, more primitive statements.

Secondly, the statement $A = B$ allows the statement A to be replaced by statement B any place in the model. Conversely, the statement B may be replaced by statement A. This leads to substitution as a major principle in mathematics. This substitution property of equality works in many areas of mathematics including algebra, geometry, and trigonometry.

In algebra, you are already aquainted with the substitution principle when you solve an equation such as $5x + 6 = 16$ and get $x = 2$. In the check of the problem $5(2) + 6 = 16$, you are using this substitution property. Also, when you replace the components of the ordered pair (6,3) in the equation $3x - 5y = 3$, you are using the substitution property of equality.

This substitution property enables one to replace an entire member of one equation with an expression within another equation. Generally, this is an extension of the types of things which you have been doing in the past. Specifically, if you have two equations such as $x + y = z$ and $3z + 2x + y = 10$, using the substitution property, a new equation $3(x+y) + y = 10$ can be formed. Thus this substitution property of equality can be used together with linear systems to develop algebraic methods to solve linear systems.

Questions:
1. What are the two methods which can be used to find the solution set to a linear system?
2. What is the statement that is basic to the algebraic methods?
3. Given the equations $4x + 5y + 3z = 10$ and $z = 2x + y$, what is the new equation formed when $2x + y$ is substituted for z?

Day Four

In your instruction you have been exposed to two methods for finding the solution set to a linear system. These methods were the graphing method and the substitution method. It will be recalled that in graphing, the solution set for each equation was plotted. In the case where you had a linear system in two unknowns, the graphs of the solution sets were lines. The coordinates of the point of intersection of the two lines gave the solution to the system.

In the substitution method the procedure was to reduce the number of variables in one of the given equations to one variable. This new equation can be solved by methods which were developed earlier in the algebra course. Once this is done the values for the remaining variables can be calculated through a series of numerical substitutions.

Both methods have advantages and disadvantages. In the geometric method the graph gives a visual picture. However, it is not always possible to read the coordinates of the points of intersection from the graph. In which case the accuracy of the substitution method may be preferred. When the system contains three variables, the graphs must be drawn on a three-dimensional coordinate system. In this system the graph of an equation such as $3x + 5y + 6z = 10$ is a plane and a system of such planes may have a very complicated graph. This makes reading the solution very difficult.

Questions:
1. What are the two methods for finding the solution set to a linear system in two unknowns?
2. Is it always possible to read the solution to a system from its graph?
3. In a three-dimensional coordinate system what is the graph of the equation $3x + 56 + 6z = 10$?

Day Five

We have seen that the substitution property of equality can lead to an algebraic method of determining the solution to a linear system. There are other properties of the equality statement which lead to an algebraic method for determining solutions to linear systems. These properties include the basic lays of equality addition and multiplication.

Early in algebra we learn that adding equals results in equals. That is, if $A = B$ and $C = D$ then $A + C = B + D$. The statements A, B, C, D can represent members (sides) of a linear equation and frequently in mathematics this is the way in which the statement is used. For example, if $2x + y = 5$ and $2x + 2y = 16$ then $(2x+y) + (2x+2y) = 5 + 16$. The multiplication property of equality states, if $A = B$ then $a \cdot A = a \cdot B$. When this rule is applied to a linear equation the distributive property of multiplication over addition must be used to derive the new form of the equation; i.e., $4\ (3x+y = 6)$ $4(3x+y) = 4 \cdot 6$ $12x + 4y = 24$.

These properties of the equality statement can be used together with systems of linear equations to develop a second algebraic method for finding solutions to linear systems. This method is often called the addition method and together with the substitution method make up two algebraic methods for finding solutions to linear systems.

Questions:
1. What two properties of the equality statement are used in the addition method?
2. May the addition property of equality be used with linear equations?
3. How many algebraic methods for solving linear systems do you know about?

Day Six

You have been exposed to three methods for finding the solution set to a linear system in two unknowns. They consisted of one geometric method and two algebraic methods. The geometric method, where graphs of the individual equations were drawn, gave a visual representation of the problem. However, there were reasons, mainly the inaccuracies of this method and the fact that it could not very easily be extended to systems of more than two unknowns, which motivated us to find other methods.

These methods were algebraic in nature and relied primarily upon the equality statement for their validity. The strategy in the substitution method was to reduce the number of variables in one of the given equations to one and solve this new equation with the methods developed earlier in the algebra course. The value of the other variables could then be calculated through numerical substitution within the original equations. In the addition method the coefficients of one of the variables in the given equations were made additive inverses (opposites) so that adding the given equations resulted in a new equation which contained one less variable. In the case where the system contained only two variables, the new equation could be solved using techniques developed earlier in the course.

When presented with a linear system, there is no one method which must be used. You may choose which method you feel best "fits" the problem and a combination of methods may be used. It is beneficial to be familiar with each method, since each may be used in other type systems. Graphing gives some idea of what the solution set of a system should be and gives approximate values for these elements. The substitution method can be extended for use in non-linear systems, i.e., $x^2 + y^2 = 25$, $x + y = 3$. The addition method can be extended for use in linear-systems with several variables, i.e., $2x + 3y + 4z = 2$, $-5x + 5y + 2z = 4$, $3x - 4y - 6z = 2$. In conclusion, you may decide which method you wish to use in a particular problem, although a knowledge of all methods will be of considerable benefit to you as you proceed through the algebra course.

Instruction Moves: ECECCCC / ECC; CEC / CEC / CEEE / CECCC / EEC; 5CE / CCCE; 7CEC / CCE; CCCCECECCC; 9CECEC.

Control Introductions: The control introduction for the first lesson was a short passage describing the historical development of the use of algebraic procedures in mathematics. For the remaining five lessons, the control group worked on a problem similar to the questions which were answered on the previous day.

Learning Activities: A teacher taught how to solve systems of linear equations by graphing, substitution and addition. The students had a set of materials to work from and overhead projections were used. The students worked many examples and had a series of questions to answer at the end of each lesson.

Andrews, 1972-73

Source: journal article.
Concept: Discoveries make life more enjoyable.
Advance Organizer: The following passage was presented via audio tape.

Discoveries may make life more enjoyable, more exciting, or more meaningful. All of you will make discoveries for the rest of your lives. Some of these discoveries may make one or two of you famous; the rest of us will enjoy our discoveries privately. No discovery, however, seems very important unless it relates to a special interest, hobby, or experience one has had.

Unless you are conscious of women's fashions you may not know that a synthetic hair has been discovered which allows a wig to keep its curl even when washed. Another discovery has made it possible to take three-dimensional pictures through a process called holography.

The story you are about to read is about a discovery, this one made in the Philippines by a Mohammedan chieftain. The story begins in a small fishing village where the author, an American archaeologist, hears a sad, mournful wailing: one of the native pearl divers is missing. You will read how a giant clam figures in his disappearance.

Next, the giant clam is brought to shore where one of the head men of the tribe-Panglima Pisi-orders that the giant clam be opened. Inside the giant clam is a pearl just as large. And, this pearl has truly remarkable features about it.

After seeing why the giant pearl is so fascinating, you will read about the author's offer to buy the pearl, for any price, from the chief. What happens proves the point that discovereis are most meaningful when they relate to memorable experiences or to special interests of people.

Instructional Moves: CCCCEEEC.
Control Introduction: Students listened to an audio tape instructing them to consider the motives of one of the characters in the story.
Learning Activities: The students read the story, "The Pearl of Allah," from the SRA Reading Lab IIa.

Ausubel, 1960; R.A. Graber, 1972; Graber, et al, 1972; Munford, 1971; Young, 1975

Source: dissertation - received from Graber, Department of Education, Illinois College, Jacksonville, Illinois 62650; also available on microfilm (Graber, Munford, Young).
Concept: relationship between internal grain structure of alloys and their physical properties.
Advance Organizer: Students read the following passage.

Metals and Alloys

Metal has certain unique advantages over other substances as a material for tools and implements. It is hard, strong, durable, and can be molded to any desired shape. When no longer required for a particular use it can be melted and made into a new product. But even more important, perhaps, is the fact that it has a wide diversity of properties under the control of man.

Many important physical properties of metal depend upon its internal grain structure. We can, therefore, alter the properties of a given metal by changing its internal structure. Both heat and various mechanical processes modify the internal structure and hence the properties of metals. Heat, for example, changes the grain structure of metals in such a way as to soften them, and hammering at room temperature changes their grain structure in such a way as to harden them.

Nevertheless, despite the possibility of modifying the internal structure of metals by heat and mechanical means, the range of properties available among pure metals is obviously limited by the existence of only a small number of pure metals. Hence, if man restricted himself to the use of pure metals he would only have a limited variety of grain structures and a correspondingly limited range of physical properties at his disposal.

It is true, of course, that pure metals do have certain unique functions that alloys cannot perform, especially in laboratory instruments. For most practical purposes, however, it is expedient to alloy a metal with other metals or non-metals, and thus take advantage of the much wider selection of grain structures and physical properties which thereby becomes available. Generally speaking, other elements are alloyed with metals to confer such properties as increased hardness, strength, toughness, and flexibility. Almost any desired combination of physical properties can be developed to meet the specific requirements of a metal part by selecting an appropriate metal, by choosing suitable kinds and percentages of alloying elements, and by subjecting the resulting alloy to appropriate mechanical and/or other procedures.

It is clear from the foregoing, therefore, that the properties of a given alloy, like those of a pure metal, are (within certain limits) determined by its distinctive grain structure. This structure in turn depends upon the particular metal and the specific type and amount of alloying substance used. Alloys also resemble pure metals in the fact that their internal structure also varies with temperature. Unlike pure metals, however, the grain structure (and hence the properties) of some alloys are modified by the rate at which they are cooled.

Hence, before we could predict the grain structure and properties of an alloy belonging to the latter category of alloys, we would not only have to know (a) its temperature, and (b) its principal metal component, and the type and amount of alloying substance used, but also (c) the rate at which it was cooled.

Instructional Moves: C 7E 5C.
Control Introduction: Students read a short passage on the history of the development of the metallurgy of iron and its alloys.
Learning Activities: Students read a 2500-word passage on the properties of steel and the relationship between the properties and the procedures followed in the production of the steel.

Ausubel and Fitzgerald, 1961; Ausubel and Youssef, 1963

Source: The materials were not obtained for this study. Ausubel was contacted; he did not respond. Several attempts were made to obtain adresses for Fitzgerald and Youssef, but none were successful.
Concept: Buddhism.
Advance Organizer: Both comparative and expository organizers were written. Students read only one. The comparative organizer identified the principal similarities and differences between Buddhist and Christian doctrines. The expository organizer presented the main doctrines of Buddhism at a high level of abstraction, generality, and inclusiveness with no reference to Christianity.
Control Introduction: Students read a passage containing historical and human interest material about Buddha and Buddhism.
Learning Activities: Students read a passage dealing with the Buddhist concepts of god, immortality, soul, faith, salvation, morality, and responsibility.

Ausubel and Fitzgerald, 1962

Source: The materials were not obtained for this study. Ausubel was contacted, but he did not respond. Several attempts were made to obtain an address for Fitzgerald, but none were successful.
Concept: Hormonal factors initiating pubescence.
Advance Organizer: Students read a passage which described the different kinds of uniformity and variability prevailing among the primary and secondary sex characteristics.
Control Introduction: Students read a passage dealing with differences and similarities in behavioral aspects of pubescence among different cultures.
Learning Activities: Students read a passage which covered specific hormonal factors affecting the initiation and regulation of the development of pubic characteristics.

Barron, 1970

Source: ERIC microfiche.
Concept: Physical properties of stars.
Advance Organizer: Students read the following passage.

Two words which scientists find extremely useful are "similar" and "different." These terms assist them in making comparisons.

Various characteristics may serve as the basis for a comparison. For example, you might compare people on the basis of similarities or differences in their relative height, weight, or strength. You might also base your comparison on more than one measure. If you consider height and weight together, you could compare people on the basis of their body build.

In like fashion, astronomers use the terms "similar" and "different" to make comparisons between stars. However, comparisons between stars are made on the basis of color, brightness, surface temperature, size and mass, rather than height, weight, or strength. Astronomers can also base their comparisons on more than one measure. Stars can be compared on the basis of both color and brightness through the use of something astronomers call an H-R diagram.

Stars, like people, appear to change as they get older. Suppose you were interested in finding out how people's height changes as they get older. You could do this in several ways. One way to do it is to take groups of people of various ages, measure their height, and compare differences in height between the various age groups. In like fashion, astronomers determine how stars change as they get older. Within certain limits, the astronomers can approximate the ages of various stars. Then they compare older and younger stars in terms of characteristics such as size, color, etc. In this way astronomers can hypothesize about how stars change with age.

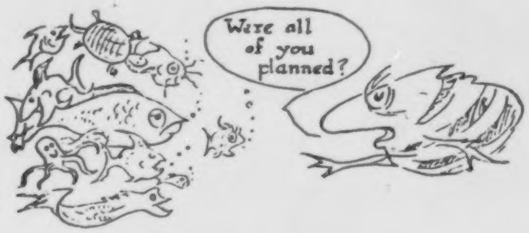
Instructional Moves: 8C.
Control Introduction: None.
Learning Activities: Students read a passage which described the characteristics of a number of stars at various ages.

Barrow, 1973

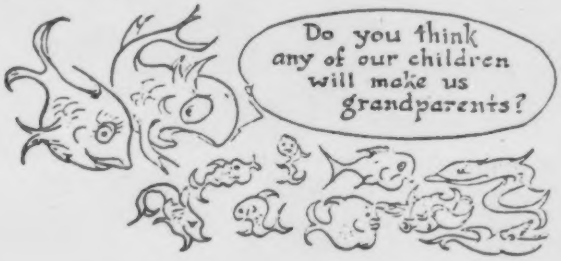
Source: dissertation - microfilm.
Concept: evolution.
Advance Organizer: Students read the following passage.

Evolution is where organisms living today are different from those that lived in the past. Evolution is change. Organisms change slowly with the passage of time. Evolution is concerned with the changes within organisms.

The change within organisms can be the type where a simple organism has evolved into a more complex organism over a long period of time. Or, there can be changes within a group of organisms. All of these changes are happening together. Sometimes certain things will speed up evolution while other times it will be slowed down. Listed below are the things that bring about evolution.


Were all of you planned?

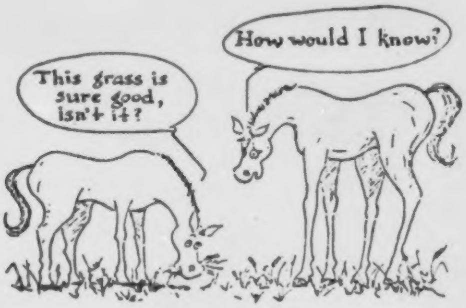
All types of life reproduce at higher rates than is necessary to continue the existence of that group.


Do you think any of our children will make us grandparents?

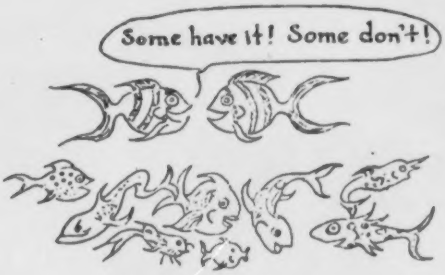
All living things within a group do not look alike; therefore, these differences will help to continue the existence of the group.

There lies your Uncle Zeek, son. He couldn't outrun those tigers since he had only three legs.

Survival of the fittest by natural selection means that only the adults that are able to reproduce will have their characteristics passed on to their offspring.


This grass is sure good, isn't it?
How would I know?

Within the biosphere there is a limited amount of food; therefore, the organisms that are best suited to use the food will survive and reproduce.


Some have it! Some don't!

Through the process of inheritance, each generation will develop its own variation within the group.

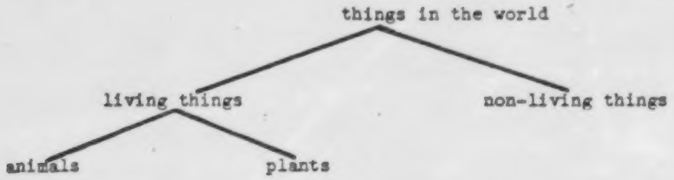
Instructional Moves: 5C 5E.
Control Introduction: Students read a short description of the Scopes "monkey trial". It contained a number of cartoons.
Learning Activities: Students engaged in classroom work on the principles of evolution and evidence for evolution. They were given a list of behavioral objectives and printed materials with diagrams. They did laboratory activities and discussed a number of questions.

Bernard, 1975

Source: Research and Development Center for Cognitive Learning, University of Wisconsin, Madison; also available on ERIC microfiche.
Concept: behavior management procedures.
Advance Organizers: An advance organizer was prepared for each of these lessons. The students read the appropriate organizer prior to each lesson on three consecutive days.

Day One

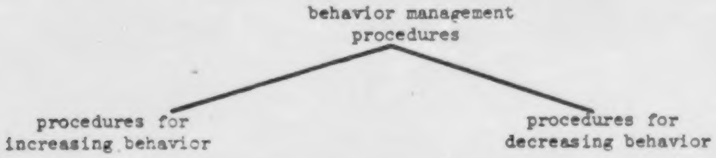
A taxonomy is a way of distinguishing, ordering, and naming groups of related things or ideas. The following is an example of a taxonomy of all things in the world.



This taxonomy shows that living things and non-living things are subsets of all things in the world. Plants and animals are subsets of living things.

In taxonomies, the things or ideas that are lower down in the taxonomy are also examples of things higher in the taxonomy. All animals are also living things. All non-living things are also things in the world. Make sure you understand what has been said, before going on.

There are two subsets of behavior management procedures that people use. They are presented in the taxonomy below:


behavior management procedures
procedures for increasing behavior
procedures for decreasing behavior

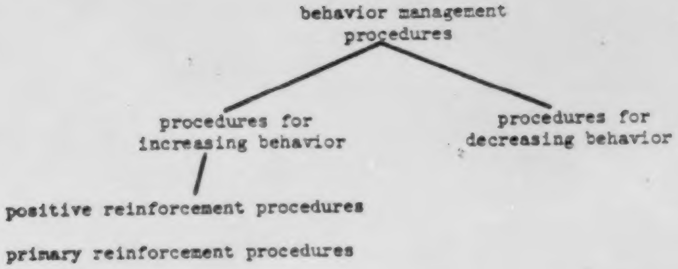
One subset is procedures for increasing behavior. They are used by a person to increase the number of times a person's behavior occurs. Examples of particular behavior which people want to increase are "making one's bed," "handing in assignments on time," and "getting a friend to keep a promise."

The other subset is procedures for decreasing behavior. These behavior management procedures are used to decrease the number of times a person's behavior occurs. A teacher may think that smoking pot before class is a behavior that ought to be stopped. A girl may be making herself "overly attractive" to boys/and her friends may want to eliminate what they consider to be a problem behavior.

In the following lesson, you will learn about a subset of procedures for increasing behavior called positive reinforcement procedures. All positive reinforcement procedures are also procedures for increasing behavior.

You will also learn about a subset of positive reinforcement procedures called primary reinforcement procedures. All primary reinforcement procedures are also positive reinforcement procedures.

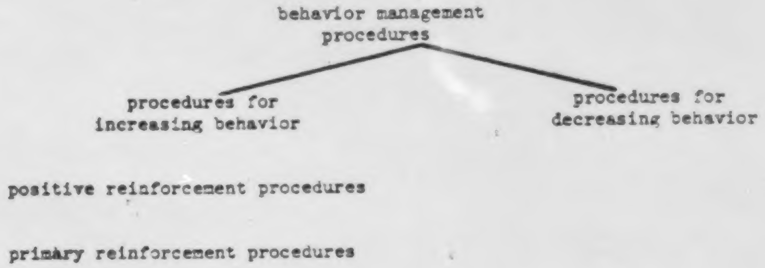
Both positive reinforcement procedures and primary reinforcement procedures are added to the behavior management taxonomy.


behavior management procedures
procedures for increasing behavior
procedures for decreasing behavior
positive reinforcement procedures
primary reinforcement procedures

Study this taxonomy carefully. It will help you in understanding and remembering procedures you are about to learn.

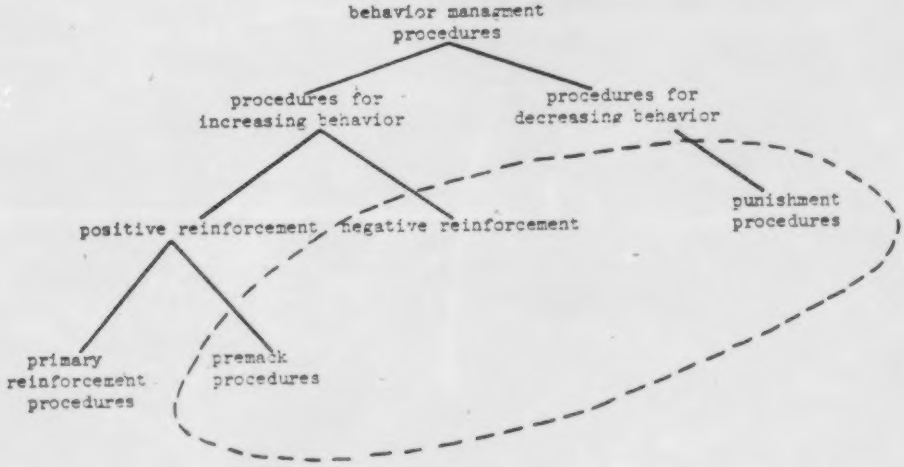
Day Two

Yesterday, you learned something about the following five different procedures that are presented in the taxonomy below.


behavior management procedures
procedures for increasing behavior
procedures for decreasing behavior
positive reinforcement procedures
primary reinforcement procedures

The most general of them are behavior management procedures. These are either procedures to increase behavior or procedures to decrease behavior. You learned that positive reinforcement procedures is a subset of procedures for increasing behavior. Also, primary reinforcement procedures are a subset of positive reinforcement procedures.

Today you will learn about two other procedures that are used to increase a behavior, and one procedure that is used ot decrease the number of times a behavior occurs. The new procedures are presented in the oval that is in the taxonomy below.


behavior management procedures
procedures for increasing behavior
procedures for decreasing behavior
positive reinforcement
negative reinforcement
punishment procedures
primary reinforcement procedures
premack procedures

Premack procedures are also a subset of positive reinforcement procedures. Positive reinforcement procedures are either primary reinforcement procedures or premack procedures.

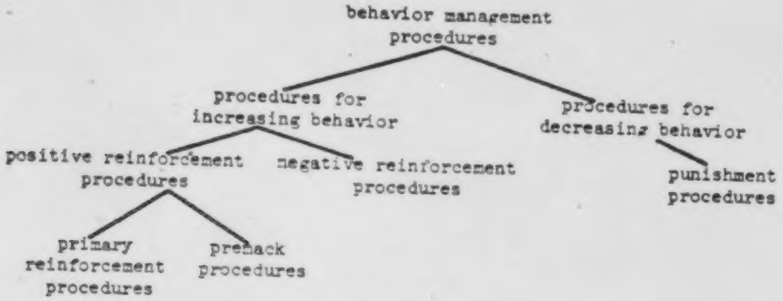
Another subset of procedures for increasing behavior is negative reinforcement procedures. Procedures for increasing behavior are either positive reinforcement procedures or negative reinforcement procedures.

Finally, you will learn about one kind of procedure for decreasing behavior called punishment procedures.

Again, study the new taxonomy carefully. It will help you to distinguish among the procedures you will learn in Lesson 2.

Day Three

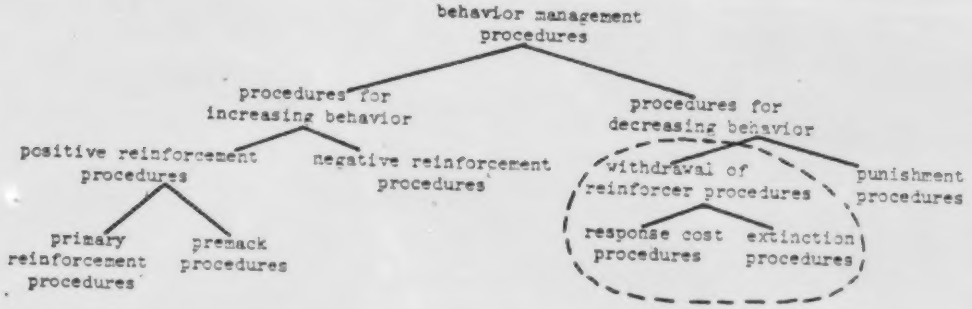
Over the past two days, you learned something about the following eight different procedures.


behavior management procedures
procedures for increasing behavior
procedures for decreasing behavior
positive reinforcement procedures
negative reinforcement procedures
punishment procedures
primary reinforcement procedures
premack procedures

Remember the higher a procedure is in the above taxonomy, the more general it is. Behavior management procedures are more general than procedures for increasing behavior. Positive reinforcement procedures are more general than premack procedures.

Procedures that are lower in the taxonomy are subsets of those higher in the taxonomy. For instance, punishment procedures are subsets of procedures for decreasing behavior. Primary reinforcement procedures are examples of positive reinforcement procedures.

Today you will learn about three other kinds of procedures for decreasing behavior. The three new procedures appear in the circle in the taxonomy below.


behavior management procedures
procedures for increasing behavior
procedures for decreasing behavior
positive reinforcement procedures
negative reinforcement procedures
withdrawal of reinforcer procedures
punishment procedures
primary reinforcement procedures
premack procedures
response cost procedures
extinction procedures

Withdrawal of reinforcer procedures are subset of procedures for decreasing behavior. Response cost procedures and extinction procedures are subsets of withdrawal of reinforcer procedures.

Look at the taxonomy carefully.

Instructional Moves: CCCEEC; CCCCEE / CCECECE; CCEE / CEE / CCEEE.
Control Introduction: None.
Learning Activities: Students read a set of materials which defined a number of behavior management procedures and gave a number of examples of each. They also responded to a number of questions within the materials.

Bertou, 1971; Bertou, Clasen, and Lambert, 1972

Source: Materials were not obtained. It was not possible to get an address for Bertou. Clasen was contacted but did not respond. The Bertou (1971) dissertation is not available from University Microfilms because of copyright.
Concept: origins and production of atomic energy.
Advance Organizer: Students observed a six-minute, video-tape presentation. The specific content was not identified in the research report.
Control Introduction: The advance organizer on the video-tape was replaced by six minutes of neutral material for the control group.
Learning Activities: Students observed a thirty-minute video-tape on the origins and production of atomic energy. Half of the students in the AO group and half the students in the control groups saw a tape which had questions placed throughout the presentation.

Billey, 1969

Source: dissertation-microfilm. Two experiments are reported in the dissertation: one on the topic of learning and one on the topic of behavioral objectives.

Learning

Concepts: classical conditioning and operant conditioning.
Advance Organizer: Students read ten pages from the text, Introduction to Psychology, by Ernest R. Hilgard and Richard C. Atkins on (Cambridge, Mass: Harcourt, Brace and World, Inc., 4th ed., 1967, pp. 271-280). The following topics are covered: Pavlov's conditioning experiments, classical conditioning, reinforcement, extinction, spontaneous recovery, operant conditioning, and experiments with the "Skinner box". Because of its length, only part of it is reproduced here.

The Nature of Learning

Classical Conditioning: Pavlov's Experiments. The study of associative learning can be carried on in the conditioned response experiment. This experiment was originated by the Russian physiologist and Nobel prize winner, Ivan Pavlov (1849-1936). While studying the relatively automatic reflexes associated with digestion, Pavlov noticed that the flow of saliva in the mouth of the dog was influenced not only by food placed in the dog's mouth but also by the sight of food. He interpreted the flow of saliva to food placed in the mouth as an unlearned response, or, as he called it, an unconditioned response. But surely, he thought, the influence of the sight of food has to be learned. Hence, this is a learned or conditioned response. Pavlov experimented to find out how conditioned responses are formed. He taught the dog to salivate to various signals, such as a rotating disk or the sound of a metronome, thereby proving to his satisfaction that a new stimulus response association could be formed in the laboratory.

Under Pavlov's method a dog is prepared for experimentation by having a minor operation performed on its cheek, so that part of the salivary gland is exposed to the surface. A capsule attached to the cheek measures salivary flow. The dog is brought to the soundproof laboratory on several occasions and is placed in a harness on a table where the experiment is to be conducted. This preliminary training is needed so that the animal will stand quietly in the harness as the experiment proceeds. The laboratory is so arranged that meat powder can be delivered to a pan in front of the dog by remote control. Salivation is recorded automatically. The experimenter can view the animal through a glass panel, but the dog is alone in the experimental room.

A light (the conditioned stimulus) is turned on. The dog may make some exploratory movements, but it does not salivate. After a few seconds, the meat powder (unconditioned stimulus) is delivered; the dog is hungry and eats. The recording device registers copious salivation. A few more trials are given in which the light is always followed by the meat, the meat by salivation. (This following of the conditioned stimulus by the unconditioned stimulus and response is called reinforcement.) After several reinforcements, the dog salivates when the light is turned on, even though food does not follow. When this happens, a conditioned response has been established.

Instructional Moves: CECECCCC / CCCECECC / CEC / CE7CECECECECECCCEEEEC.
Control Introduction: Students read a passage on the stages of development of a baby.
Learning Activities: Students attended lectures on learning.

Behavioral Objectives

Concept: behavioral objectives.
Advance Organizer: Students read a passage defining advance organizers. Several examples were included to illustrate the various characteristics of behavioral objectives. Because of the length of the advance organizer only the first part of it is reproduced here.

Writing Instructional Objectives

For many years, educators have talked about the importance of instructional objectives. The purpose of an instructional objective is to make clear to teachers, students, and other interested persons what it is that needs to be taught--or what it is that has been taught.

A well-written instructional objective should say three things: 1) what it is that a student who has mastered the objective will be able to do, 2) under what conditions he will be able to do it, and 3) to what extent he will be able to do it. To put the matter in a single sentence, a well-written instructional objective should specify under what conditions and to what extent a certain kind of student performance can be expected to take place.

Performance-conditions-extent. Let us consider first the word performance. Performing means doing. A student who performs something does something.

Here are two statements. Which one is expressed in terms of student performance?
A. The student will have a good understanding of the letters of the alphabet A through Z.
B. The student will be able to pronounce the name of the letters of the alphabet A through Z.

Statement B tells what it is that the student will be able to do. He will be able to pronounce the names of the letters of the alphabet A through Z.

Statement A tells us that the student will have a good understanding of the letters of the alphabet. But this is not very clear. We cannot tell what it is that the student is supposed to be able to do as a result of this understanding.

Let's try another pair of statements. Which one is expressed in terms of student performance?
A. The student will have an adequate comprehension of the mechanics of punctuation.
B. Given a sentence containing an error in punctuation, the student will correct the mistake.

Statement B tells what it is that the student will do. Statement A, which says that the student will have an adequate comprehension of the mechanics of punctuation, is pretty vague. We cannot tell what it is that the student is supposed to be able to do as a result of his comprehension.

At this point, an objection may be raised. Isn't the person who is comprehending something doing something? Isn't intellectual performance an acceptable kind of student performance?

Certainly. The difficulty is that mental activity, as such, is not directly observable. We cannot literally open up a person's head and see the thinking that is going on inside. If it is to be of use to us, a statement of performance must specify some sort of behavior that can be observed.

This does not mean that we are not concerned about intellectual performance. It does mean that since mental activity, as such, is not directly observable, some sort of behavior that is observable will have to stand for or represent the intellectual performance we have in mind.

For example, suppose that we are interested in having students know something about the writing style of Ernest Hemingway. Whatever may be intellectually involved in the attainment of this goal, it should be apparent that the language of our aim as stated leaves much to be desired. What is the student who knows able to do that the student who does not know is not able to do? This is the important question, because we cannot measure the accomplishment of our instructional purpose until we have worked out a clear answer to it. Although there is no single answer (our objective of "knowing something" is too vague for that), here is a possible statement of desired performance: Given ten pairs of short prose passages, each pair of short prose having one selection by Ernest Hemingway and one by a different author, the student is able to choose the ten selections written by Hemingway with at least 90 percent accuracy.

Performance-conditions-extent. We have been talking about performance. Let us now consider conditions.

Here is one of our earlier statements concerning the alphabet: the student will be able to pronounce the names of the letters of the alphabet A through Z. We have said that this statement is expressed in terms of student performance. Does this statement also set forth the conditions under which the performance is to take place?

It does not. For one thing, we cannot tell from our statement whether the student is to pronounce the names of the letters at sight or from memory. If the letters are to be shown, we do not know whether the student is to work with capital letters, small letters, or both. Nor do we know whether the student is to work with these letters in regular sequence or in random order. Obviously, each set of conditions is substantially different from the rest, and will make its own special demands upon the student who attempts to accomplish the objective.

Instructional Moves: CCCCEECCEECCC / EECEECC / CECECEC / CEC / EC / CEC / EC.
Control Introduction: Students read a passage entitled " A Psychoanalytic View of Socialization."
Learning Activities: Students attended lectures on behavioral objectives.

Blount, Klausmeier, Johnson, Fredrick, and Ramsay, 1967

Source: Some materials are included in the report. A letter requesting the complete set of materials was sent to Blount, but he did not respond.
Concept: sentence (in grammar).
Advance Organizer: Advance organizers were prepared for ten lessons. The students read each organizer prior to each daily lesson. The organizer for lesson 1 was the only one included in the report.

Lesson 1 Organizer

In order to describe something, we usually look at the whole thing and then look at the parts. Knowing the parts and how they fit together helps us in our description. If we are dealing with a number of things, we frequently put them into groups in order to make our description clearer and more organized. During the next two weeks, you will be using this approach in learning to describe English sentences.

One of the first things you will learn is that all sentences may be described in terms of certain basic sentence patterns. There are nine basic sentence patterns in the English language. These nine patterns might be compared to the primary colors that an artist uses. All hues can be obtained from mixtures of red, blue, and yellow which are the three primary colors. Similarly, every sentence you read can be described as taking the form of one of the nine basic sentence patterns, or as a combination or rearrangement of the nine basic sentence patterns. Here are two groups of sentences:

Group 1	Group 2
John is president.	John is older.
The boys are a team.	The boys are tall.
All of the men were policemen.	All of the men were happy.

Although each of these sentences is different, we can classify Group 1 as belonging to one of the nine basic sentence patterns and Group 2 as belonging to another.

Let's look at the sentences again in another way:

John + is president.	John + is older.
The boys + are a team.	The boys + are tall.
All of the men + were policemen.	All of the men + were happy.

These sentences, like every sentence which may be constructed in the English language, can be divided into two main parts. You will learn to call the part to the left of the + sign the subject group and the part to the right of the + sign the predicate group. For the first lesson you will work with the subject group. In all nine basic sentences, the subject group is always a noun phrase. In other sentences, which are rearrangements or combinations of basic sentences, the subject group may or may not be a noun phrase; in basic sentences it is always a noun phrase.

As you learn about noun phrases, you will discover that the last word in all noun phrases is a noun, What is a noun? Rather than depending on the traditional definition of "noun" as the "name of a person, place, or thing," you will learn to use the noun test-sentence. If a word fits in the noun test-sentence, it can be used as a noun. In a later lesson, you will be given other ways which will help you identify nouns.

These pages you have just read are meant to give you a brief overview of today's lesson. Now that you have an idea of what you will be learning, you are ready to begin Lesson 1.

Instructional Moves: CCC 6EC / 6E 7C.
Control Introduction: Students read an historical passage which discussed some of the views of the ancient Romans and Greeks on language development.
Learning Activities: Students worked through a programmed booklet each day. Lesson 1 covered subject and predicate groups, and the noun test-sentence. Lesson 2 covered the first two basic sentence patterns and the adjective test-sentence.

Bonner, 1974

Source: dissertation - microfilm.
Concept: political revolution.
Advance Organizer: Students read the following passage.

Revolutions

A revolution may be thought of as a war between two or more disagreeing groups. The difference between a regular war and a revolution is that in a revolution the fighting groups are usually from the same country or are ruled by the same rulers. Often, the main point of disagreement between the fighting groups is whether or not one of the groups should be free from the rule of the other.

Very often, countries or groups which are not directly involved in the revolution become interested in helping one of those which is fighting. Sometimes, these outside countries are interested in helping only because they feel they can gain something from their involvement.

Many times reports of battles in revolutions are exaggerated. When this happens, people's feelings about the revolution become very strong even though they really might have no interest in which side wins the revolution. When these feelings get very, very strong, it is not uncommon for another country to send troops to help one group in its fight against another.

Instructional Moves: CCCC.
Control Introduction: Students read a short passage describing a number of geographical facts about Cuba.
Learning Activities: Students observed a TV lecture. The lecture discussed the events and political atmosphere leading to the American involvement of the Cuban revolution against Spain. Picture cards were presented with the lecture.

Brewer, 1974

Source: dissertation- received from author, U.S. Army Management Engineering Training Agency, Rock Island, Illinois 61201; also available on microfilm.
Concepts: data processing systems, computer data storage, computer programs, programming languages, input/output media for computers, management of processing systems.

Advance Organizer: Organizers were prepared for four units of instruction. Because of the length of the materials, only the organizer for Unit I is reproduced here. An outline of the topics covered in the other organizers is also given. Students read each advance organizer before the beginning of each lecture. Students were allowed to keep the advance organizers and take them home during the four days of instruction.

Unit I

TYPES OF DATA PROCESSING: Data processing involves the recording, collection, storage and conversion or processing of data into information and reports. The functions of data processing may be performed by several different methods including:

1. Manual systems utilizing pencil and paper.
2. Key driven systems utilizing calculators and other mechanical devices.
3. Punched card accounting systems utilizing electrical/mechanical devices (now largely obsolete).
4. Automatic data processing systems utilizing digital electronic computers and other electronic devices.

Today it is very common to find various combinations of these data processing methods integrated within a large data processing system. The digital computer has become the heart of many of these systems. However, it should be remembered that a data processing system need not be automated or use a computer.

In very simple terms, a digital computer performs arithmetic operations on data as directed by a program of instruction prepared by a human. As a process, the computer inputs data and instructions, stores them in memory during processing, performs arithmetic and comparison operations as required by the instructions, and outputs information--all at electronic speed.

EVOLUTION OF DATA PROCESSING: The use of automated devices in data processing is not a new phenomena. Early historical records provide evidence that the abacus (a mechanical computational device) was used centuries ago. However, it was not until after World War I that key-driven mechanical computational devices came into general use. And not until after World War II were electronics applied to problems of business data processing. Since the introduction of electronics, there has been a technological explosion in this field. Computers were invented and evolved through three generations within a period of only 25 years. Successively vacuum tubes, transistors, and integrated circuits have been used in each generation to lower costs, increase processing speeds, and reduce the size of computer hardware. The result has been a tremendous increase in the scope and extent of computer based automatic data processing applications.

COMPUTERIZED DATA PROCESSING OPERATIONS: Computerized data processing involves the following three basic operations:

1. INPUT - This operation involves all the activities necessary to gather and submit data for computer processing. Under automated data processing systems a wide variety of cards, papers, tapes, and other devices are used to record, collect, and prepare data for input in a computer's CPU.

2. PROCESSING - This operation includes the manipulation of data inputs according to a prearranged plan called a program. The program consists primarily of machine instructions to add, subtract, multiply, divide, store, amke comparisons, and generate outputs.

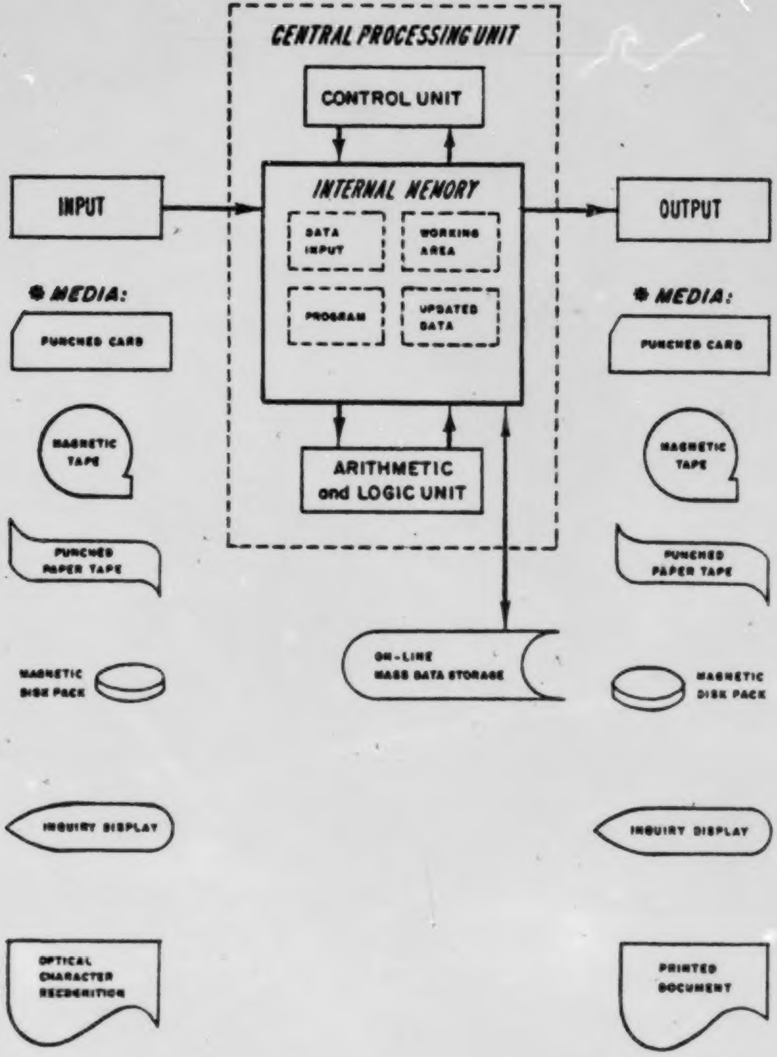
3. OUTPUT - This operation includes the preparation of various reports, files, and other documentation that are used by management or as input to other programs.

ELEMENTS OF A COMPUTER SYSTEM: A computer system consists of the computer and various peripheral and support equipment. The computer performs the actual arithmetic and logical operations required to convert data into information. The peripheral and support equipment exists to facilitate the operation of the computer itself.

The central processing unit (CPU) is the heart of an electronic digital computer (See Figure 1). Basically, it consists of (1) a control unit, (2) internal memory, and (3) an arithmetic and logic unit. The control unit interprets processing instructions provided to the computer and directs all data processing operations. Internal memory functions as a temporary storage for processing instructions (the program) and data. The arithmetic and logic unit performs arithmetic and comparison operations using data and instructions routed from internal memory as directed by the computer.

Peripheral equipment is directly connected to an controlled by the CPU. Card readers, magnetic tape stations and printers are examples. Support equipment is not connected to the CPU. Key punches, sorters and interpreters are examples of this type of equipment. Most computer systems require a great deal of support and peripheral equipment if they are to be operated efficiently and effectively.

Figure 1. PROCESSING DATA BY THE COMPUTER



Most peripheral equipment is limited in speed of operation by its mechanical components. However, the CPU can operate full time at electronic speed. Thus, when a program is run, the computer's CPU is effectively utilized only a small part of the time while it waits for data inputs and information outputs. This was a significant problem with first and second generation computers.

Third generation computers have been designed to greatly increase utilization of the CPU. Using sophisticated control programs, it is now possible to run several programs concurrently. Thus while data is being input for one program, the CPU is processing the data for another program and so on. These systems are frequently used where a number of users, each using different programs, are connected by terminals to a single centralized computer.

CPU INTERNAL MEMORY: The rapidly expanding use of the computer can be attributed to its electronic speed for processing data and its internal memory. The CPU's internal memory is perhaps the primary reason for the growth in the use of computers.

Memory in a computer is actually a very simple form. It exists as some type of "either/or" situation. Thus, a magnetic spot exists or it doesn't, an electrical current is flowing in a wire in one direction or the opposite, and so on. Alpha, numeric, and other special characters are stored in the CPU's internal memory by the use of various combinations of these spots and no spots, or direction of current flow. Memory can be changed at electronic speed and it always exists in one of these simple forms.

Internal memory may be limited to a few thousand characters or range into the thousands and even millions in some of the very large computers. A typical memory is constructed of very small donut-shaped ferrite cores with small electrical wires running through them. A flow of current is used to magnetize/demagnetize these cores and thus represent characters.

Unit II Topics

- procedures and equipment for data storage for computer use.
- the binary coding system.
- input/output media used by computers.

Unit III Topics

- data processing by computers.
- magnetic storage devices.
- developing computer programs.
- programming languages.

Unit IV Topics

- guidelines for the effective management of data processing systems.

Instructional Moves: CCEEEECCCC / CEEECC / CCC / 11C / CC; CCCEE / CEEE / CCCCEEEC 5ECC; 13C / 9C / CCCCEE 9C / CCC; 16C.
Control Introduction: None.
Learning Activities: Students attended lectures. The lectures incorporated student exercises, student discussions, films, and slides. The students also had a text and they were provided with a list of objectives and a summary of topics to be covered.

Brovey, 1969

Source: dissertation - microfilm.
Concepts: geological change at the earth's surface.
Advance Organizer: Students read the following passage.

The earth is constantly changing; volcanic eruptions and mountain building forces create new and dramatic landscape elements. Even while in the process of formation, however, these landscapes are being attacked by various forces. Given sufficient time, the mountains, plateaus, and hills will be lowered to the level of the sea. The island of Manhattan having a relief of two hundred sixty-eight feet is such a landmass being worn down.

To better understand the elements involved in sculpturing the landscape, it is convenient to classify the various processes responsible for land denudation into three categories: Weathering is the term used to describe the adjustment of materials to an environment different from the one in which they were formed. Rock masses formed beneath the earth's surface and now exposed represent material adjusting to a new environment. This adjustment takes the form of both mechanical disintegration and chemical decomposition through which materials are formed that are more stable at the surface environment.

The products of weathering -- sediments -- may remain in place and hence form a soil or be moved to a lower elevation under the sole action of gravity or by fluids (gases and liquids) acting in conjunction with gravity. Mass wasting is the term that represents the yielding of earth materials (soil, rock debris, or bedrock) when the force of gravity exceeds the internal strength of the material, resulting in the sliding, falling, or flowing of material to lower elevations. Erosion is the term that describes the removal, transportation, and deposition of material by fluids under the force of gravity. These fluids -- the erosive agents -- include flowing water, waves, glacial ice, and wind. These agents form erosional landscape features (features formed where deposition takes place). Thus, e.g., waves form erosional features such as sea arches and depositional features such as sand bars.

An alternative way to describe rock breakdown into smaller fragments is to classify the various geometrical forms that the rock fragments might take. Thus, we might find a particular rock that separates along fractures in the rock mass into large blocks; other rock masses tend to break down into individual particles by separation along the mineral contact planes in the rock. Other geometrical varieties are also possible.

In the field a visual examination of the structure of the rock mass can provide much useful information. On the basis of color, e.g., it is possible to make a decision as to whether the rock mass is homogeneous or whether it is composed of distinct types of material. Similarly a visual inspection will reveal whether the surface of the rock is smooth or rough; whether there are layers present in the rock; whether the spatial orientation of the layers is horizontal, vertical, or folded; whether the rock body is a solid mass or whether it is broken.

The nature of particular agents of landscape sculpture is generally evident to a careful and critical observer. Familiar locations, such as Central Park, can provide many evidences of landscape change and sculpture.

Instructional Moves: CEECCE CECEEECC / EC / ECEEEE / CEE / C 5E / CE.
Control Introduction: Students read an historical sketch of the landscape changes in the New York City area.
Learning Activities: Students visited field cities to observe geological features which were described in a written passage which they read at each site. An instructor was with each group to identify the relevant feature at each cite.

Callihan, 1975

Source: dissertation - microfilm.
Concept: sampling distribution of the mean.
Advance Organizer: Students read the following passage.

As you know by this time, the sample mean is a worthwhile measure for estimating the unknown population mean. Suppose a random sample of n observations has been taken from some finite population of size N or some infinite population and X is computed, say, to estimate the mean of the population. It should be clear to you that if we independently took a second random sample of size n from this population, it would be quite unreasonable to expect identically the same value for X, and if we took several more samples, probably no two of the Xs would be alike. It is in this sense that we may look upon X as a random variable. The differences among such Xs are generally attributed to chance, and this raises important questions concerning how they distribute themselves, specifically concerning the extent of their chance fluctuations which would, of course, involve a careful treatment of the standard deviation associated with the distribution of X.

We shall approach this question in the period of time that follows and conclude it with one of the most elegant and important results in all of statistics. One would suspect that the underlying population--whether it be normal, uniform, skewed, or symmetric--might have a profound effect upon the character of the X values. Comparing the values of the sample statistics, X and S, to those corresponding parameters of the population, and , would seem to be a worthwhile consideration since the random sample is representative of the population. It is surely an amazing accomplishment for man that such chance phenomena can be described and predicted mathematically using probabilities associated with a standard normal z-distribution.

Let's give it a try! You may wish to think about what you've read here as we move through the new material.

Instructional Moves: CCCCC.
Control Introduction: Students read a passage dealing with some aspects of statistics which were not covered lecture: need for stating probabilities associated with statements of results and the importance of sample size for valid generalizations.
Learning Activities: Students listened to a lecture on sampling distributions and the central limit theorem. Overhead projections and demonstrations were used, but there was no student-teacher or student-student interaction.

Caponecchi, 1973

Source: received from author, Box 2273, Norman, Oklahoma, 73070.
Concepts: mathematical systems (rings and fields), and matrices. While matrices and their operations constitute a mathematical system, it was identified as a separate concept because of the way it's presented in the advance organizer and because the learning activities deal specifically with matrices.
Advance Organizer: Students read the following passage and answered a set of fifteen questions based on the information in the passage.

This is an introduction to a unit that you will be studying shortly, a unit on matrices and their operations. A set of elements together with some operations defined on those elements create a mathematical system. The sets that we will be discussing here are sets of numbers. You have had lots of experience working with the real numbers and the operations of addition, subtraction, multiplication, and division.

A mathematician has a very precise concept in mind when he talks about an "operation" on a set of elements. To understand how a mathematician thinks about an operation, we must begin with the idea of an ordered pair of elements. As the name implies, an *ordered pair* refers to a pair of elements in which the choice of which element is written first is of prime importance. For example, if the elements are 2 and 5, then (2,5) denotes the ordered pair where 2 is first and 5 is second. A mathematician thinks of an operation as a process whereby an element of a given set is assigned to an ordered pair of elements from the same set. For example, if you were asked to tell which element is assigned to the ordered pair (2,5) when the operation is addition, you would undoubtedly give the correct response of 7. Similarly, you would say that 10 is assigned to (2,5) when the operation is multiplication. The idea of assigning elements of a set to ordered pairs of elements from the set is really not so new to you; you've actually been doing it for years but simply not thinking of it this way or writing it this way. Instead of saying: "7 is assigned to (2,5) under addition," you wrote (much more briefly): 2 + 5 = 7.

When working with an operation, we have to have some means of determining which element (if any) is to be assigned to a given ordered pair. We are usually given some rule for doing this. Consider the following operation defined on the set of real numbers:

With any ordered pair (a,b) assign the real number that is half-way between the two if a is less than b; if a is greater than or equal to b, assign the number a.

Accordingly, with (2,4) we assign 3; with (5,9) we assign 7. But with (4,2) we assign 4 and with (9,5) we assign 9. With the ordered pair (4,4), we assign 4. If we label our operation with the symbol, #, we could write the above assignments as:

2 # 4 = 3; 5 # 9 = 7; 4 # 2 = 4; 9 # 5 = 9; 4 # 4 = 4

For a given operation, a specific ordered pair has *at most* one element from the set assigned to it. As an example, consider the set of whole numbers, W = (0,1,2,3,4,5,....). Under addition, 7 is the only element of the set assigned to (2,5); under multiplication, 10 is the only element of the set assigned to (2,5). In some cases, there is *no* element *in the set* assigned to some ordered pairs. For the ordered pair (2,5) we would ordinarily assign -3 when the operation is subtraction (i.e., 2 - 5 = -3). But -3 is *not* a whole number. We would have to extend the set under consideration to include the negative whole numbers before the operation of subtraction could always be performed. Some care must be taken to be sure that the operation can be performed with certain ordered pairs; one cannot always proceed without some caution.

When a mathematician studies an operation, he tries to determine what kind of rules or properties the operation has. Many times a set of elements will have two operations defined on it, and in such cases the mathematician will investigate the system for properties that show relationships between the operations. Also, he examines a mathematical system looking for elements which have unique properties with respect to the operations. Specifically, in the course of your work with the real number system, you learned many important properties or rules which these numbers obeyed with respect to the operations of addition and multiplication. You have used these properties frequently, although you may not have been aware of them at times. There are, however, some important mathematical systems which do not obey all of these rules, and in which care must be taken before the rules can be applied. In particular, the following properties among others hold on the set of real numbers for the operations of addition and multiplication:

If a, b, c denote arbitrary real numbers:

1. Commutative law of addition: $a+b = b+a$. For example, $3+2 = 2+3$. The number 5 is assigned to both ordered pairs (3,2) and (2,3).
2. Associative law of addition: $(a+b)+c = a+(b+c)$. That is, when adding three numbers, we may proceed in either of two ways: $(7+8)+5 = 15+5 = 20$ OR $7+(8+5) = 7+13 = 20$.
3. Associative of multiplication: $(ab)c = a(bc)$. Three factors in a product may be associated in either of two ways: $(3\cdot 5)4 = (15)4 = 60$ OR $3(5\cdot 4) = 3(20) = 60$.
4. Distributive law: $a(b+c) = ab+ac$. Thus, $7(6+3) = 7(6)+7(3)$. This property gives us a means of relating the operations of addition and multiplication.
5. Identity element of addition: There exists a unique number, 0, with the property: $a+0 = 0+a = a$.
6. Inverse law of addition: Every a has an opposite, -a, such that: $a+(-a) = -a+a = 0$.

In mathematics, a special word has been coined to describe systems, all of whose elements satisfy the above six properties. The word "ring" is used to describe such a system. Since the set of real numbers satisfies all of these properties, it forms a ring. One may speak of the "ring of real numbers," and in so doing he implies that the real numbers satisfy the above laws.

We might check some of the subsets of the real numbers to see if they form a ring. Does the set of whole numbers, W = (0,1,2,3,.....), form a ring? Certainly properties 1 through 4 will hold, since every whole number is a real number and these properties do hold for the real numbers. Property 5 is also satisfied since 0 is a member of W. What about property 6 (additive inverses)? Consider the whole number 4; there is no member of the set W which will allow this property to be satisfied for the number 4 (of course, -4 is the element we need, but it is not a member of W). Thus W does not form a ring.

Does the set of integers, I = (...,-3,-2,-1,0,1,2,3,.....), form a ring? Again, properties 1 through 4 will immediately be true, as was the case with the whole numbers. Also, property 5 is satisfied for all integers, since 0 belongs to I. Now we do have additive inverses for all of our numbers, so property 6 is satisfied. So the set I does form a ring.

Thus not all sets of numbers with the operations of addition and multiplication form what we call a ring. A ring is a fairly sophisticated mathematical topic, and the real numbers are just one example of this concept. There are other examples, but none are as familiar to you as are the real numbers. The real numbers also satisfy certain other rules with respect to addition and multiplication which we have often used as well as the above six. In particular, they meet the following three requirements:

7. Commutative law of multiplication: $ab = ba$. For example, $5(3) = 3(5)$. The number 15 is assigned to both ordered pairs (5,3) and (3,5).
8. Identity element of multiplication: There exists a unique number, 1, with the property: $a\cdot 1 = 1\cdot a = a$.
9. Inverse law of multiplication: Every nonzero number a has a reciprocal, 1/a, such that $a(1/a) = (1/a)a = 1$. So we have $1/4(4) = 1$ and $25(1/25) = 1$.

If a set of elements satisfies the six ring laws and the seventh property just listed, it is called a commutative ring. If we have a ring which also satisfies property 3, we call it a ring with identity. The set of integers, I, forms a commutative ring with identity, since this set satisfies the seventh and eighth requirements. If a set of elements should happen to satisfy all nine laws which we have listed, it is given another special name; it's called a "field."

It is worth noting again that not all sets of elements upon which have been defined the operations of addition and multiplication will satisfy all or even some of the above rules. You will shortly be studying such a set of elements, the set of matrices.

The system of matrices will provide an excellent comparison to the system of real numbers. We will see that there are very obvious similarities between these two sets of elements and their operations. You will also note that there are some striking differences between the two systems. We wish to take special note of these similarities and differences.

A matrix is a collection of real numbers which is arranged into rows and columns. We keep track of matrices by the number of rows and number of columns each contains. A matrix will in general contain many real numbers, with each number entered in a row and column position. In defining addition and multiplication of real numbers, these operations are so defined that *any* two real numbers can be added or miltiplied. These operations will be defined on matrices in such a way that *not* all matrices can be added to each other, and *not* all matrices can be multiplied. However, for those matrices which can be added, the operation will be commutative $A + B = B + A$, associative $(A+B)+C = A+(B+C)$, have an identity element, and each matrix will have an additive inverse. For those matrices that can be multiplied, we will always have the associative property $(AB)C = A(BC)$, and the distributive law will always be satisfied $A(B + C) = AB + AC$.

Multiplication of matrices will, in general, not be commutative. There will exist matrices which can be multiplied and for which $AB \neq BA$. Similarly, a multiplicative identity will exist for some (but not all) matrices, and a multiplicative inverse will exist for some (but not all) matrices.

The set of matrices under the operations of addition and multiplication will not form a ring, since not all matrices can be added or multiplied. However, there is a certain type of matrix which will satisfy all six of the ring properties, and the set of all matrices of this type will form a ring.

When you begin your study of the matrix system, the ideas presented here should be valuable to you. Try to keep in mind the similarities and differences of this system when compared to the real number system with which you are familiar.

Instructional Moves: CCEC / ECECECECC / ECCECC / 15C.
Control Introduction: Students read a bibliographic sketch of the mathematician, Arthur Cayley, who introduced the use of matrices in mathematics.
Learning Activities: Students attended classroom lectures on matrix algebra.

Clawson, 1972a; 1972b; Clawson and Barnes, 1973;
Rice, Barnes, and Clawson, 1972

Source: dissertation - microfilm.
Concepts: culture, cultural change.
Advance Organizers: The classroom teacher used ten advance organizers for three chapters of work. They consisted of a unit organizer, three chapter organizers, and six topic organizers for Chapter III. Each organizer had a study guide. Because of the length of the materials and copyright, only the organizers for the unit and for the topic of urbanization from Chapter III are given here. The topics covered in the other organizers are identified.

Unit Organizer - The Changing World Today

This book is about cultural change in three countries. The three countries are Japan, Kenya, and India.

Culture is the way of life of a group of people. All the ways of living are part of culture. The people of the United States have a culture. The people of Japan, Kenya, and India have their own cultures. All cultures are not the same.

Cultures change. They do not stay the same year after year. Cultures change in many ways. This book is about some of the important ways that cultures change.

Japan is an example of industrial modernization. Modernization means to change from old ways to new ways of doing things. Japan is a country that has modernized its way of making things. Japan has changed from making things by hand to making things by machines. Changing from making things by hand to making things by machines is called industrialization. Industries in cities need workers. The growth of cities is called urbanization. So the big ideas here are:

cultural change in Japan: modernization
industrialization
urbanization

Kenya is an example of nationalism. Most of the African countries have become independent since 1950. Wanting your country to be independent and feeling proud of your country is called nationalism. A big idea in understanding Africa today is understanding nationalism.

Although there are new nations in Africa, there are many tribes in each country. A tribal group is a cultural group. Tribalization, belonging to a tribe, is an important idea in understanding Kenya.

All kenyans do not live in small villages. Many Kenyans live in modern cities and work in factories. Modernization is bringing about change through urbanization and industrialization. The big ideas here are:

cultural change in Kenya: nationalism
tribalization
modernization
industrialization
urbanization

India is an example of planned agricultural change. Most people in India live in farm villages and make their living by farming. The government of India has a plan to help Indian farmers to grow better crops, make more money, and have more things in their culture. The big ideas here are:

cultural change in India: planned agricultural change

All cultures change. They change in many ways. This book is about four important ways that cultures change -- industrialization, urbanization, nationalism, and planned agricultural change.

Chapter I Organizer - Culture

This organizer gave a general definition of culture as a people's way of life with reference to cultural universals and trait variations.

Chapter II Organizer - Cultural Change

This organizer described a number of ways that cultures change and gave examples.

Chapter III Organizer - Industrialization and Urbanization in Japan

This organizer gave a brief outline of the changes in Japan which resulted from contact with western countries and Japan's need for trade. This chapter contained topic organizers with the following titles:

1. Japan Begins to Modernize
2. Industrialization
3. Growing Populations and Growing Industries
4. Urbanization
5. Results of Modernization
6. Selctive Diffusion

Chapter III Topic Organizer - Urbanization

An urban area is a city area. Most of the people in Japan live in urban areas. The growth of cities is called urbanization.

Japan imports and exports many things. Most of the goods that are imported and exported are carried in ships. The large urban areas in Japan are close to the sea. At one time most of the Japanese people lived in small villages. This has changed. Today most of the people live and work in urban areas.

Many changes that have come to Japan start in cities. People from small villages are influenced by what happens in the cities. The large newspapers are often printed in large cities. Radio and television stations are located in cities. When people travel to the city, they see the changes that are taking place.

Many of the new ideas that start in the cities find their way to the villages.

Instructional Moves: CEEEEC / CCECE ECECEECCEEEE; 20C; CCEEEE 7C / CCEC / 10C; 11E / CE / CEEE / CEE; 7E; CCEE; E; 7E; 7E; 5E.
Control Introduction: None.
Learning Activities: Students received classroom instruction based on a text book covering culture, cultural change, and cultural change in Japan. There were a series of thought questions and review test questions at the end of each chapter. The advance organizer classes used a text which contained the organizers immediately preceeding the relevant material.

Dawson, 1965

Source: dissertation - microfilm.
Concept: plastics.
Advance Organizer: Students read the following passage.

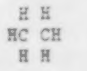
Plastics have played an important part in the development of our present standard of living. They have been vital to our defense, helped win the last World War, and are used in thousands of peace-time activities. Plastics have been instrumental in the development of the automobile; are the lifeline of all modern communications including telephone, television, and radar; and perhaps more than any other material make our homes beautiful and comfortable.

Plastic brings together into one substance the good qualities of many materials. It can be sawed and hammered like wood; cast, rolled, and welded like metal; woven like wool and cotton; and printed like paper. Plastics can be classified commercially into three groups depending upon their chemical composition. They are synthetic resins, cellulose plastics, and protein plastics.

Let us consider a substance which might represent the "average" plastic. Call it Plastic X. The average person would glibly say that it is made of coal and air. In effect this statement is true because it is made of the element carbon, which is taken from coal, and oxygen, hydrogen, and nitrogen which come from air. Today, the scientist has found hundreds of thousands of ways to put these elements together, and a mere list of possible plastics would fill a book. Plastic X is composed of tiny particles called molecules. These molecules are made of atoms which are the smallest items known to man. The splitting of atoms of certain elements like uranium have enabled scientists to make the atom bomb.

The carbon atom, which is the basis of Plastic X, combines easily with other elements making long chains. When heat is applied to atoms the bond between them becomes weaker. If enough heat is applied to the atoms in Plastic X they will separate and the plastic will bend or melt. Sometimes under heat or pressure two or more molecules will join together to make a large molecule. This process is called polymerization and is the key to the making of plastics.

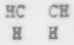
The physical properties and different types of plastics depend on the kind of molecules and the way they are arranged in the basic material. Ethane, for example, is made of carbon (C) and hydrogen (H). A molecule of ethane would look like this:



$$\begin{array}{cc} H & H \\ HC & CH \\ H & H \end{array}$$

Ethane

To change ethane to ethylene like the material found in some gasolines, just knock off two of the hydrogen atoms and the molecule will look like this:



$$\begin{array}{cc} HC & CH \\ H & H \end{array}$$

Ethylene

The ethylene molecule is very unstable and can be changed easily. As heat and pressure are applied the molecules join together and make polyethylene which is one of our most important plastics in use today. Other plastics are made in the same way as polyethylene but have different basic elements, and the molecules are arranged differently. Nylon, for example, is a well-known plastic which is used for stockings, brushes, rugs, fishing line, and thousands of other items. It is very strong and can be boiled in oil without ill effects. Over 80% of the better tooth brush bristles are made of nylon. When you brushed your teeth this morning, chances are that you used a brush made of chemicals taken from coal, air, or water.

Many weird and wonderful plastic items can be found in every phase of life today including work, home, school, and play. Plastic wire can be purchased which is stronger than galvanized steel. There are plastic dog "bones" cast with built-in flavor. Plastic parts which function perfectly are replacing vital organs of the human body. Plastic glue is so strong that one drop between two steel plates is capable of picking up a ten-ton truck. Plastic pepe so light that a man can easily carry a 30-foot piece of six-ince pipe is common today. Plastic clothes are being made so inexpensively that they can be thrown away rather than cleaned. There seems to be no end to the magic being performed with plastics.

Last year, approximately 4,500,000,000 pounds of plastic were produced in the United States. This is enough to provide every person in the country with 25 pounds in a single year. Look around you to see how many ways your 25 pounds of plastic have been used.

Instructional Moves: CCC / 5C / CEEE / 6CECEE / C 5ECC.
Control Introduction: None.
Learning Activities: Students read a passage on the history, characteristics, uses, and manufacturing processes of plastics.

Eastman, 1977

Source: journal article.
Concept: solution sets for quadratic inequalities.
Advance Organizers: Two advance organizers were prepared for the topic of solving quadratic inequalities. These were matched with two different approaches to teaching the topic during the learning sessions. One used an analytical treatment while the other used a verbal-spacial-numeric (graphical) treatment. The students read the following passages. No student read more than one organizer.

Analytical Organizer

This is a brief introduction to the material that will follow. It is meant to help you understand the concepts involved in solving quadratic inequalities. You should read the material carefully, but you should not be upset if you do not understand what the relationships are in the discussion below. The material that follows this introduction gives a more detailed presentation of the techniques involved in solving quadratic inequalities.

In solving inequalities of the form $(x - a)(x - b) > 0$ or $(x - a)(x - b) < 0$, where a and b are constants, it will be important for us to know some of the important relationships and facts concerning these inequalities. Some of these important relationships and facts are:

1. There is a relationship between the inequality $(x - a)(x - b) < 0$ and the equation $(x - a)(x - b) = 0$.
2. There is a relationship between the signs (+ or -) of the factors of the inequality $(x - a)(x - b) < 0$.
3. There is a relationship between the sign (+ or -) of the factors of the inequality $(x - a)(x - b) < 0$ and the direction ($<$ or $>$) of the inequality.
4. The constants in the inequality divide the set of numbers into three subsets.
5. There is a relationship between these subsets of numbers and the solution of the inequality.

A_1: A number may be added or subtracted from both members of an inequality without changing its solution set.
A_2: If a, b, and c are numbers with $a < b$ and $b < c$, then $a < c$.
A_3: A product is negative when the number of negative factors is odd, provided none of the factors is zero.
A_4: A product is positive whenever the number of negative factors is even, provided none of the factors is zero.

A_5: For every number a, a is less than a + 1.
A_6: If the product of two factors is zero, then at least one of factors is zero.

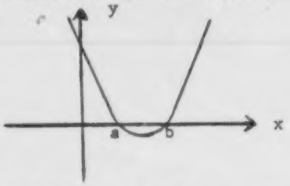
In the material to follow, we will be investigating these relationships in an effort to learn how to solve quadratic inequalities. Now continue on in your programmed booklet.

Graphical Organizer

This is a brief introduction to the material that will follow. It is meant to help you understand the concepts involved in solving quadratic inequalities. You should read the material carefully, but you should not be upset if you do not understand what the relationships are in the discussion below. The material that follows this introduction gives a more detailed presentation of the techniques involved in solving quadratic inequalities.

In solving inequalities of the form (x - a)(x - b) 0 or (x - a)(x - b) 0, where a and b are constants, it will be important for us to look at the graph of the inequality and see some of the important relationships and facts which can be derived from the graph.

Graph of y=(x - a)(x - b)
y
a
b
x



Some of these important relationships and facts are:
1. The relationships between the graph of the inequality $(x - a)(x - b) < 0$ and the graph of the equation $y = (x - a)(x - b)$.
2. The constants in the inequality are the points where the graph crosses the x-axis.
3. The relationship between the parts of the graph that are above (or below) the x-axis and the direction (< or >) of the inequality.
4. The constants in the inequality divide the number line into three subsets.
5. The relationship between the subsets of the number line and the solution of the inequality.

A_1: A number may be added or subtracted from both members of an inequality without changing its solution set.
A_2: If a, b, and c are numbers with $a < b$ and $b < c$, then $a < c$.
A_3: A product is negative when the number of negative factors is odd, provided none of the factors is zero.
A_4: A product is positive whenever the number of negative factors is even, provided none of the factors is zero.
A_5: For every number a, a is less than a + 1.
A_6: If the product of two factors is zero, then at least one of factors is zero.

In the material to follow, we will be investigating these relationships in an effort to learn how to solve quadratic inequalities. Now continue on in your programmed booklet.

Instructional Moves: 5C; 4C.
Control Introduction: Students read a short passage which contained a brief statement that the learning materials involved solving quadratic inequalities and a list of examples of inequalities. The same control introduction was used for both sets of experimental materials.
Learning Activities: Students worked through programmed instructional booklets on methods for solving quadratic inequalities. Separate booklets using the analytical and graphical approaches were prepared. Each advance organizer was matched to the appropriate booklet according to the approach used.

Edwards, 1976

Source: dissertation - microfilm. The dissertation reported three separate experiments-one each at grades 3, 4 and 6. Four sets of materials (advance organizers and learning passages) were prepared for grades 3 and 4. Three sets of materials were prepared for grade 6.

Grade 3

Concepts: care of pets, interaction of living things, birds, and human communities.
Advance Organizers: Students read the following passages.

Care of Cats and Dogs

In this story, you will learn how to take care of some pets. You will learn that cats and dogs need just enough of the right kind of food and exercise. They need to be warm and clean. Boys and girls can help them stay healthy.

A Community of Living Things

In this story you will read that many living things help each other. These living things make up a community. Birds, worms, squirrels, and trees live together in a kind of community. They all help each other in their community.

Birds

In this story you will read about some small birds. They live in an oak tree. Birds must look for food all year. They must protect themselves and their eggs. They also help the oak tree. In fact, the tree and the birds help each other.

Communities

In this story, you will read that many families make up a community. Most communities have schools and churches and places to play. People work together to take care of their community and each other. People need each other in many ways.

Instructional Moves: 5C; CEC; 5C; 6C.

Grade 4

Concepts: importance of trucks to man, impact of railways in American history, and microbes.
Advance Organizers: Students read the following passages.

Trucks, Trucks, Trucks!

In this story you will find out that trucks are very important to us. They do many different kinds of work. Trucks carry many things and help people in many ways. Trucks need roads and highways in order to be useful to people.

How Microbes Live

In this story, you will read about some tiny living things called microbes. Microbes "eat" many of the same things you do in order to live. Some microbes are harmful, such as germs. Others are very helpful to man in several ways.

Railroads Yesterday

In this story, you will read that the early trains in America caused many changes. Towns and farms grew up near the tracks. Many people took trips on trains for an adventure. Indians and train robbers would sometimes cause problems for the trains.

How Microbes Were Discovered

In this story, you will learn how a scientist discovered microbes. Under his microscope, he saw many tiny things darting about. No one else had ever seen these things. Scientists today call them microbes and have discovered many things about them.

Instructional Moves: CCCC; CCCEC; CCCC; CCC.

Grade 6

Concepts: matter, man's impact on the life of the falcon, and the impact of trading on occupations.
Advance Organizers: Students read the following passages.

What's the Matter?

In this story, you will read that scientists define "matter" as anything that takes up space and has mass. There are many kinds of matter - wood, air, water, and others. You may find matter in a solid, liquid, or gas state. You may classify matter by its composition, or make-up.

An Endangered Species

In this story you will read about the problems of peregrines, or falcons. Peregrins are large, brave, and loyal birds. However, they have been dying out over the last 20 years. Scientists are trying to find and prevent some of the causes of peregrins' deaths.

From Barter to Big Business

In this story, you will learn that people used to trade things before they had money. First, people traded things such as food with each other. Later, they began trading with other tribes. One result of trading was that people began to specialize in making or trading certain things.

Instructional Moves: CC 6EC; CCC; CEEC.
Control Introduction: None.
Learning Activities: Students read short passages on the various topics. All materials were read at one session in the sequence organizer, learning passage, organizer, learning passage, etc. Students were instructed to read each passage only once. The control group, which did not have any introductory materials, was instructed to reread the learning passage for 30 seconds after they had finished reading it completely through once. Students took only one test which covered all the materials they had read.

Felker, 1973

Source: dissertation-microfilm.
Concepts: types of behavior (operant and respondent), respondent conditioning, operant conditioning, and extinction.
Advance Organizers: Advance organizers were prepared for four chapters of study. Students read the following passages immediately before each chapter.

Chapter 2 Organizer

The human being is a complex organism capable of making many different kinds of responses. Some of these responses take place automatically whenever certain events occur. These capabilities are within humans from time of birth and need not be practiced to be performed. Other kinds of responses, however, require much practice to be performed well. These responses are gradually shaped over time and are what sets man apart from other living organisms. Together, these two forms of responses represent the behaviors available to man.

Chapter 3 Organizer

One kind of human learning often occurs as the result of an accidental pairing of some event that causes an automatic response with another event that does not cause any particular response. This kind of learning happens when the automatic response occurs in the presence of the event that does not cause any particular response. This learning happens because of specialized conditions surrounding the pairing of events. The number of times the two events are paired is one important condition, the time between the pairings is another, and the sequence in which the events are presented is still another important condition.

Chapter 4 Organizer

Humans and most other living organisms enjoy those phenomena that give them pleasure. Because of their nature, organisms tend to do and to learn those activities that result in some type of pleasure or satisfaction for them. Pleasurable events can be "made to happen" in many situations and, consequently, is an important ingredient in influencing and controlling what an organism does and how it behaves.

Chapter 6 Organizer

All responses that are ever learned are not performed even when the conditions under which learning originally to place are present. Some responses are forgotten, and some can be learned not to happen. The conditions for bringing about the unlearning of behavior revolve around some of the same basic factors that cause learning in the first place. The role of pleasure and satisfaction are important for both learning and unlearning, differing only in how they are utilized. Just as the presence of pleasure and satisfaction can influence what is learned, so can their absense influence what is unlearned.

Instructional Moves: 6C; 5C; 2C; 5C.
Control Introduction: none.
Learning Activities: Students read Chapters 2, 3, 4 and 6 from the text, Learning: Reinforcement Theory, by Keller (1968). Each chapter followed the corresponding organizer.

Feller, 1973

Source: dissertation-microfilm.
Concepts: bonding energy, activation energy, and catalysts.
Advance Organizer: The following passage was read to the students.

The atoms in a molecule of any substance are held together by forces of attraction, something like the attraction between magnets. Suppose you think of atoms as being like marbles, each one having a bar magnet through its center. Now imagine that the end of the magnet is at the surface of the marble and that there is a small spring at the end of each magnet. If two marbles hit each other hard enough, the springs will be pushed together so the magnets can come close to each other and hold the two marbles together. Atoms behave something like this. The energy needed to bring the atoms together is stored up, just as the compressed springs of our magnetic marbles store energy. This energy is given up as the atoms are separated, just as energy is released if the springs push the marbles apart.

Scientists believe that atoms and molecules are in motion at all times. Atoms and molecules will occasionally bump into each other, but they usually bounce off without any change. Scientists think that chemical reactions involve atoms which collide with enough force to break the forces of attraction, causing them to separate. Using the idea of magnetic marbles, you can see that if two marbles are joined together and you wish to separate them, another marble could be made to hit the two joined marbles with enough force to break the magnetic attraction. If the marble is moving too slowly, it will bounce off the two joined marbles. The marble can't just hit the pair anywhere; it must hit them in such a way that the two will fly apart. For example, hitting one of the marbles on the end so that it is pushed against the other will not cause them to separate. Separation would occur more easily if you hit the pair from the side near the point where they are joined.

The atoms and molecules that make up matter are moving at different speeds and only a few of the collisions are forceful enough to produce a reaction. This is because most atoms are moving too slowly. However, you can speed up a reaction by heating, because heating makes all the atoms move faster. And, more collisions will occur in a given amount of time.

Suppose, however, that you know that heat will destroy or somehow alter a particular chemical. What other means could you use to speed up a chemical reaction involving that chemical? To answer this question, let's return to our example of marbles. Imagine that you have a special kind of marble. It is shaped so that if a pair of joined marbles hit it, they would be held there and the magnetic attraction between the two joined marbles would be weakened. Now a collision could more easily cause the pair to separate. This special marble then would release the marbles to go on their separate ways, and would be ready to take on another pair of joined marbles. Does this special kind of marble sound unbelievable? Well, there are special kinds of very large molecules which work like this marble in chemical reactions. You will learn more about this special kind of molecule as you read the material in today's lesson.

Instructional Moves: 10C.
Control Introduction: Students listened to a passage on the history of the discovery of enzymes.
Learning Activities: Students read selected materials on enzymes from Chapter 6 of the BSCS revised edition (1968) of Biological Science: Molecules to Man.

Fitzgerald, 1962; Fitzgerald and Ausubel, 1963

Source: dissertation-microfilm.
Concepts: causes of the civil war.
Advance Organizer: Students read the following passage.

A Different Interpretation of the Civil War

It is widely believed that the North fought the Civil War to preserve the Union and abolish slavery. Tomorrow you will read an interpretation of the Civil War held by some prominent historians which disputes this belief. They argue, in fact, that Northern political leaders wished to destroy the democratic union of sovereign states, as formed under the Constitution, and merely used the issue of slavery to achieve this objective.

There have always been two very different approaches to government in American political history. One political group emphasized the democratic right of the people and of the individual states to rule themselves. This point of view was advocated by Thomas Jefferson, and was written into the original Constitution. Jefferson's followers, later called Democrats, were found mostly in the South.

The opposite policitcal group, the Federalists, led by Alexander Hamilton, favored a strong, centralized government with almost unlimited powers to rule the people. In Lincoln's time, advocates of the Federalist concept of government founded the Republican party. Both the Federalist and the Republican parties were primarily Northern groups.

The interpretation that you will read tomorrow argues that the Federalists were very unhappy about the rights which the Constitution granted the states and the people. It argues that at first the Federalists thought about withdrawing from the Union and establishing their own government in the North. When this idea proved unfeasible they devised a new strategy--to remain in the Union and attempt to impose their view of government on the South. They could only hope to do this by first splitting the nation into Northern and Southern policitcal camps, and then, by winning the support of the numerically dominant North, gaining political control of the country.

To accomplish their aim of dividing the North and South politically, the Federalists, and later the Republicans, deliberately played up the sectional issue of slavery. Slavery was a convenient issue to use for political purposes because of the hatred of the South which Northern abolitionists had already stirred up on this basis. Actually there was little enthusiasm in the North for abolishing slavery on humanitarian grounds, and even less for the concept of racial equality.

When Northern Republicans gained political control of the country by the election of Lincoln, the Southern states saw their way of life threatened and were forced to protect themselves by seceding from the Union. In opposing the South's secession with war, the North claimed to be preserving the Union. But the Union it was seeking to preserve was not the democratic Union of free states originally established by the Constitution, but its own unconstitutional concept of Union, limiting the right of the people and the individual states to rule themselves.

Tomorrow you will study this interpretation of the Civil War in more detail.

Instructional Moves: EEC 7E.
Control Introduction: Students read a passage dealing with the fact that there is often controversy concerning historical events. It was indicated that there is less controversy concerning the American revolution than there is concerning the civil war.
Learning Activities: Students read a passage which gave a southern point of view on the causes of the civil war.

C. J. Graber, 1975

Source: dissertation-microfilm.
Concept: ellipse.
Advance Organizers: Two advance organizers were prepared. One used an algebraic presentation and the other used a geometric presentation. Any given group of students received only one organizer. The organizer was presented as a lecture from the following sets of instructions. No student-teacher or student-student interactions were allowed.

Algebraic Organizer

List the following equations on the board for consideration:
$x^2 + y^2 + 6X - 4Y - 12 = 0$; $3x^2 - 4x - 6Y + 8 = 0$; $5x^2 - 4y^2 - 20x - 24y + 4 = 0$; $4x^2 - 4y^2 - 16x - 49 = 0$; $x^2 + 2Y^2 + 6X - 4Y - 12 = 0$; $2x^2 - 2Y^2 - 3X + 6Y - 10 = 0$; $2x^2 - 8Y^2 - 6X + 12Y + 62 = 0$.

"We are looking at a group of geometric figures called conic sections. Those which we will consider will have the general form:" $AX^2 + CY^2 + DX + EY + F = 0$

List the following specific rules: (1) Circle: $A=C\neq 0$, (2) Ellipse: $A\neq C$, $A\cdot C>0$, (3) Hyperbola: $A=C$, $A\cdot C<0$, (4) Parabola: $A=c$ or $B=0$, but not both .

Use these rules to estimate the possible graphs of the equations above. Mention that not all of our second degree equations are presented in the general form, but can be manipulated into that form. e.b. $(X+1)^2 + (Y-3)^2 = 18$ (not in gen. form), $X^2 + 2X + 1 + Y^2 - 6Y + 9 - 18 = 0$, $X^2 + Y^2 + 2X = 6Y - 8 = 0$ (gen. form)

Geometric Organizer

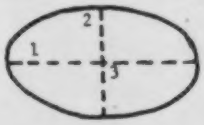
Sketch a double-napped cone and briefly show how we get the conic sections.

"Every conic section, intersection of the cone with a plan, has the general form: $AX^2 + BXY + CY^2 + DX + EY + F = 0$. For the time being we will let $B = 0$ for simplicity."

"You may have already noticed that when A and C are the same the graph may be a circle. Today we will see that for the general equation of an ellipse, A and C are different but have the same sign." "Roughly speaking, the closer A and C come to being equal, the closer the ellipse comes to being a circle."

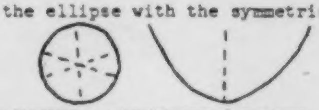
A "close" to C

A "not close" to C



Draw figure and point out symmetries:
(1) Show longest interior line segment is an axis of symmetry.
(2) Show longest interior segment, perpendicular to (1), is also an axis of symmetry.
(3) The point where (1) and (2) intersect is a point of symmetry.

Compare the symmetries of the ellipse with the symmetries of the circle and parabola.



Instructional Moves: TECC TECEEE; EEEECCCEE / ECCCEE.
Control Introduction: None.
Learning Activities: Students attended a lecture on ellipses which followed a prescribed set of notes including specific questions to be directed to the class.

R. A. Graber, 1972; Graber, et al, 1972

Source: See Ausubel, 1960. Graber used the materials on alloys developed by Ausubel.

Grotelueschen, 1967; Grotelueschen and Sjogren, 1968

Source: ERIC microfiche.
Concepts: base, face value, and place value for numbers.
Advance Organizers: Three advance organizers were prepared. One organizer used examples only from the base ten number system. The second organizer used examples only from the base seven number system. The third organizer used examples from several base number systems. All organizers were programmed instruction booklets. Because of their length, only a portion of each organizer is given below. A set of frames dealing with the concept, place value, is given for each organizer. Each organizer had approximately 95 frames. The words which the student had to fill in for each frame are underlined, and words which were underlined for emphasis in the booklet are placed in capital letters. The frames that come before the ones presented here dealt with the concepts of number, numeral, and face value. The frames following the ones presented here continued to develop the concept of place value. and also introduced total value.

Base Ten Organizer

(42) In combining numerals to write numeric symbols in base ten, we group the number ideas or values by tens. For example, the numeric symbol 24 has two groups of ten and four groups of ten and four groups of one. Three groups of ten and five groups of one is the numeric symbol 35.
(43) We group number values by ten since we use base ten. The value of each group is indicated by the column in which the numeral is placed.
(44) The numeric symbol 39 has nine groups of one indicated in the RIGHT column and three groups of ten indicated in the left column.
(45) The numeric symbol 21 means two groups of ten and one group of one.
(46) In base ten the numeric symbol 93 means nine groups of ten and three groups of one.
(47) There is no single numeral for the concept of ten. Because we group number ideas by TENS, we think: the number ten has one group of tens and no ones, so the numeric symbol is written 10.
(48) Group by tens and write the numeric symbol that represents three tens and no ones. 30
(49) Write the numeric symbol with seven tens and no ones. 70
(50) In our numeration system we combine number ideas or values in groups of ten.

(51) Because we combine number ideas in groups of TEN, we say we are working in base ten.

(52) The numeral 2 and 3 may be combined to form two numeric symbols, 23 and 32.

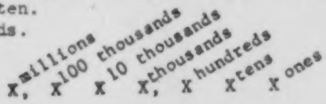
(53) So you can see that the PLACE where we write the numeral in the numeric symbol is important. The numeric symbols 23 and 32 are not the same.

(54) Each numeral takes up one place. The numeric symbol 23 has two places. The numeric symbol 1,023 has four places.

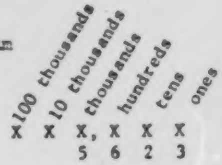
(55) The location or place of a numeral within a numeric symbol tells us what the numeral means. It is important where the numeral is PLACED in the numeric symbol. This value of the position of the numeral is called its PLACE VALUE.

(56) The value of a numeral is partially determined by its place in a sequence of numerals. This value of the POSITION of a numeral is called the place value of the numeral.

(57) The following diagram shows the place values of the first seven positions in our system which is based on grouping number ideas by ten.
An "8" in the thousands' place means eight thousands.
An "8" in the TENS' place means eight tens.
An "8" in the ones place means eight ones.

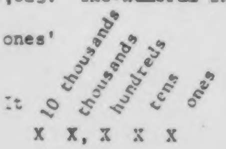


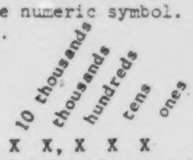
(58) When a numeric symbol has more than one place, each numeral is given a value depending on the place it is in. The above diagram shows the four-place numeric symbol 4,623. The numeral in the ones' place is 3.



(59) The next position to the left of the ones' place is called the tens' place.

(60) The place with the lowest value is at the right in the numeric symbol. It is the ones' place.





(61) According to the previous diagram, if you see the numeral 2, you know the 2 means two ones. If you see 20 you know the 2 means two tens. The position of the 2 tells you what number it represents. The 2 in 200 means two hundreds.

(62) Each place in our number system has a value. Ones, tens, hundreds, thousands, ten-thousands and so on are the PLACE values of our number system.

(63) The ones' place is the place farthest to the right in the numeric symbol. As we move left to tens, then hundreds, etc., the place values get higher.

Base Seven Organizer

(39) In combining numerals to write numeric symbols in base seven, we group the number ideas or values by sevens. The value of each group is indicated by the column in which the numeral is placed. For example, in base seven the numeric symbol 24 has four groups of ones indicated in the right column and two groups of seven indicated in the left column.

(40) In the numeric symbol 35 of the base seven system there are three groups of seven in the left column of the number and five groups of ONE in the right column.

(41) In base seven the numeric symbol 42 means four groups of seven and two groups of one.

(42) There is no single numeral for the concept of the number by which we are grouping or the number of the base in which we are working.

(43) In the base seven system there is no single numeral for the concept of seven. Because, in the base seven system, we group number ideas by sevens, we think: the number seven has on group of seven and no ones, so it is written 10.

(44) Group by sevens and write the numeric symbol that represents three sevens and no ones. 30

(45) Write the numeric symbol in the base seven system with five sevesn and no ones. 50

(46) In the numeration system based on seven we combine number ideas or values in groups of seven.

(47) When we combine number ideas in groups of SEVEN, we say we are working in base seven.

(48) The numerals 2 and 3 may be combined to form two numeric symbols, 23 and 32.

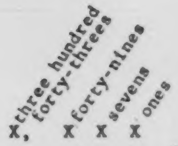
(49) So you can see that the PLACE when we write the numeral in the numeric symbol is important. The numeric symbols 23 and 32 are not the same.

(50) Cach numeral takes one place. The numeric symbol 23 has two places. The number of places in the numeric symbol 1,023 is four.

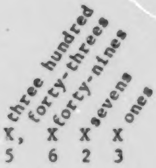
(51) The location or place of a numeral within a numeric symbol tells us what the numeral means. It is important where the numeral is PLACED in the numeric symbol. This value of the position of the numeral is called its PLACE VALUE.

(52) The value of a numeral is partially determined by its place in a sequence of numerals. This value of the POSITION of a numeral is called the place value of the numeral.

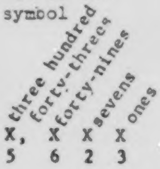
(53) The following diagram shows the place values of the first four positions in the system which is based on grouping number ideas by seven.
A "6" in the sevens' place means six sevens.
A "6" in the forty-nines' place means six forty-nines.
A "6" in the three hundred forty-threes' place means six three hundred forty-threes.



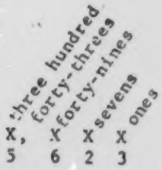
(54) When a numeric symbol has more than one place, each numeral is given a value depending on the place it is in. The above diagram shows the four-place numeric symbol 5,623. The numeral in the ones' place is 3.



(55) The place with the lowest value is at the right in the numeric symbol. It is the ones' place.



(56) In the above diagram, the next position to the left of the ones' place is called the sevens place.



(57) According to the previous diagram, if you see the numeral 2, you know the 2 means two ones. If you see 20 you know that the 2 means two sevens. The position of the 2 tells you what number it represents. The 2 in 200 in base seven means two forty-nines.

(58) Each place in the base seven number system has a value. Ones, sevens, forty-nines, three hundred forty-threes and so on are the PLACE values of the base seven number system.
(59) The ones' place is at the right in the numeric symbol. As we move left, to sevens, then forty-nines, etc., the place values get higher.
(60) In the base seven number system, the ones' place is at the right, and the places to the left are sevens, forty-nines, three hundred forty-threes and so on. As we move left, the value of each place is how many times greater than the value of the place before it? seven

Base Systems Organizer

(41) In combining numerals to write numberic symbols we group number ideas or values by the number of the base in which we are working. So in base SIX, we combine number ideas in groups of six.
(42) When we combine numerals to symbolize a number each column has a certain value, depended on the base in which we are working. For example, in base ten the numeric symbol 24 has four groups of one indicated in the right column and two groups of ten indicated in the left column.
(43) In the numeric symbol 34 in the base six system there are three groups of six in the left column of the number and four groups of ONE in the right column.
(44) Notice that the first column to the right always indicates the amount of ONES and the second column always indicates the amount of BASES there are. In Base EIGHT the numeric symbol 37 means three groups of eight and seven groups of one.
(45) In base ten the numeric symbol 93 means nine groups of ten and three groups of one.
(46) There is no single numeral for the concept of the number by which we are grouping or the number of the base in which we are working.
(47) So if we are grouping number ideas by ten and wish to write the number ten, we think: the number ten has one group of tens and no ones, so it is written 10.
(48) In base ten, we write the concept of ten as 10. The same follows in any other base. For example, group by SEVENS and write the numeric symbol that represents ONE seven and NO ones. 10 Remember the first column to the right indicates the number of ones and the second column indicated the number of bases, or the number by which we are grouping.
(49) Group by sixes and write the numeric symbol that represents three sixes and no ones. 30
(50) When we use numerals to write numbers we group number ideas. In writing numbers it is important to know the number by which you are grouping or the base in which you are working.
(51) The numerals 2 and 3 may be combined to form two numeric symbols, 23 and 32.

(52) So you can see that the PLACE where we write the numeral is the numeric symbol is important. The numeric symbols 23 and 32 are not the same.
(53) Each numeral takes up one place. The numeric symbol 23 has two places. The number of places in the symbol 1,023 is four.
(54) The location or the place of a numeral within a numeric symbol tells us what that numeral means. It is important where each NUMERAL is placed in a numeric symbol. This value of the position of the numeral is called its PLACE VALUE.
(55) The value of a numeral is partially determined by its place in a sequence of numerals. This value of the position of a numeral is called the place value of the numeral.
(56) The following diagram shows the PLACE VALUE of the first seven positions in the number systems which have characteristics similar to our numeration system.

B^0 is the base to the zero power or one, (1)
B^1 is the base to the first power or base, (B)
B^2 is the base to the second power or base squared, (BxB)
B^3 is the base to the third power or base cubed, and so on. (BxBxB)

$B^6B^5B^4B^3B^2B^1B^0$
X,X X X,X X X

(57) A numeral in the first place to the right will have the value of base to the ZERO power or ones. The second column is valued at base to the FIRST power or the base in which you are working. The third column is values at base to the second power or BASE SQUARED.

$B^6B^5B^4B^3B^2B^1B^0$
X,X X X,X X X

(58) We have stated that the first place to the right will have the value of the base to the 0 power or ones. Because ANY NUMBER TO THE ZERO POWER IS ALWAYS ONE, the first column of any number system which uses place values will be called the ONES' column or have a place value of one.

$B^6\ B^5B^4B^3\ B^2B^1\underline{B}^0$
X, X X X, X X $\overline{X}$

(59) In base eight or in any base, the column farthest to the right has a place value of one (base to the zero power).
(60) The second column from the right always has the place value of the base to the first power or, simply, the base.

$B^6B^5B^4B^3B^2B^1B^0$
X,X X X,X X X

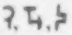
(61) In base nine the second column from the right has the value of the base or nine. In base ten this column has a place value of ten.
(62) The third column from the right always has the place value of the base squared or the base times itself. In base ten this column has the place value of ten squared (ten times ten) or hundred.

$B^6B^5B^4B^3B^2B^1B^0$
X,X X X,X X X

(63) The fourth column from the right always has the place value of the base curbed (base times base). For instance, in base two this column has a place value of two x two x two or eight.

$B^6B^5B^4B^3B^2B^1B^0$
X,X X X,X X X

(64) Each place in our number system has a value. Ones, TENS, hundreds, thousands, ten-thousands, and so on are the place values of the base ten number system.
(65) Ones, THREES, nines, twenty-sevens, eighty-ones, and so on are the place values of the base three number system.
(66) It can be seen that as we move left from column to column, the place values get higher.

Instructional Moves: CECCEC / CEEEECCECEE / CEEEC / CEC / C6ECC / CCEEEE / CEE / CEEEECE / C5ECC / C5ECCEC7E / CC9ECC5E / CC7E / C5ECC; CEEE / CEEECCECEECEC / CCEEEEC / CEEEC / 5CEEEECECCCEECECEEEEC / CEEEECCEC7E / C5E / ECCEEEE / EEECCEEECEEEECEE / CEEECCC; CECECEEEEC / CEEEECCCEEC / CEEECE / CEECCEE / CEECEECC / 5CECEECECEC10E / CCEEE / CECEEECEEE / ECCCEEEE / C6ECC7ECC;
Control Introduction: Students worked through a programmed instructional booklet on the history of units of measure.
Learning Activities: Using the symbols , and to represent the numerals 0,1,2, and 3 respectively, the students had to identify the correct sybols for the first thirteen numbers in the base four number system. The stimulus numbers were presented via teaching machines. The stimulus numbers were presented, the student responded, and the student was shown the correct response. One group of students received the numbers in sequence beginning with zero. For a second group, the first five numbers were in sequence and the remainder were in random order. For a third group, the complete set was in random order. The students had to continue through the sequence of thirteen numbers until they responded correctly for two complete and consecutive sets of numbers.

Harrington, 1968

Source: Research Paper no. 10, Laboratory of Educational Research, University of Colorado.
Concept: stimulus sampling theory.
Advance Organizer: Students read the following passage.

"Win a Trip to Acapulco" Contest

While in New York City, you decide to attend a new give-away show that is being televised nationally on NBC. To your surprise you are chosen as a contestant.

The object of this game is to get at least 10 points out of a possible 15 in order to win an expense-paid trip to Acapulco. Fewer points result in prizes ranging from a color TV to a 3-speed blender. The game consists of an electronic board which is composed of 50 squares that can be either red, white or blue. During the game the board flashes on fifteen times with different patterns and number of squares with each color. Each time the board is turned on you have the opportunity to make 4 responses: (1) press lever one, (2) press lever 2, (3) press lever 3, or (4) press none of the levers. When the correct response is made, a bell rings and you are awarded 1 point.

As the game starts you guess at a few looking for the important factor that is matched with a response. The cue may be pattern of colors or amount of one color on any of the 15 different board presentations. After three misses the bell rings as you press lever 3 when the board is showing 35 white, 10 red, and 5 blue squares. The next time the board shows mostly white squares the chances are greater that you'll press lever 3; on the other hand, the chances of pressing lever 1, 2 or not pressing any lever will be less when there are mostly white squares. If the next few times when the board shows mostly white squares you will press lever 3 and the bell rings you would reach the point where you would press the third lever every time the board is made up of mostly white squares. On the other hand, chances of your pressing any other lever would dissappear altogether.

Whether you win or not depends now on how soon you can find which of the other responses go with boards predominately of the other two colors.

Instructional Moves: E.
Control Introduction: none.
Learning Activities: Students read a passage on stimulus sampling theory.

Hartje, 1974

Source: dissertation-microfilm.
Concepts: axiomatic systems and mathematical systems.
Advance Organizers: Organizers were prepared for three lessons. An organizer covering axiomatic systems and an organizer covering mathematical systems were prepared for each lesson. One experimental group read only the axiomatic-system passages while another group read all passages.

Axiomatic Systems-Lesson 1

The axiomatic method is part of what is more commonly known as the scientific method. Our understanding of the axiomatic method is a result, to a great extent, of studies in geometry. In the axiomatic method, one begins with a few primitive terms and a set of statements, called axioms, concerning the undefined terms. The undefined terms and axioms are then used in establishing whether certain other statements, called theorems, are true or false. The truth or falsity of a theorem is established by a logical arguement. The validity of such arguements must be tested by certain laws of logic.

An axiomatic system is always involved in the axiomatic method. An axiomatic system consists of four basic components: 1) primitive or undefined terms, 2) explicity defined terms, 3) a list of statements called axioms and 4) statements called theorems.

The meanings of the primitive or undefined terms usually arise out of experience in the use of the words rather than from any formal definition. The number of primitive terms in an axiomatic system is limited to as few as possible. When the undefined terms have been identified, other terms can be defined using the undefined terms. The defined terms usually have special meansings in the system. Statements that are made concerning the primitive terms, called axioms, may also obtain their meaning or reasonableness from experience. While it is possible to establish the reasonableness of statements called theorems without a logical argument (proof), it is always possible for someone to provide a proof of such statements.

Consistency is one of the most important considerations in the axiomatic method. For a system to be consistent, there must be no contradictions in the conclusions as the result of applying the axiomatic method. To insure consistency, foresight and careful considerations must be used in selecting the axioms for the system.

The basic notion in the axiomatic method is that of selecting beginning links in a chain of reasoning. Once this is accomplished, a chain of consequences can be formed through the methods of logic. The resulting structure is called an axiomatic system.

The following is an example of an axiomatic system:

The game of tic-tac-toe has been the pastime of students for years. In playing this game, two players take turns marking either "X" or "O" in a block of nine squares, the object being to complete a straight or diagonal line of ones mark before the other player does. Your experience of playing the game should prepare the way for the selection of a few undefined terms and asioms with which to construct a logical axiomatic system of the game.

1	2	3
4	5	6
7	8	9

(fig. 1)

Two axioms are: A_1: There exists a space consisting of cells.
A_2: There exists markers consisting of crosses and circles.

Primitive Terms: 1) Cells 2) Crosses 3) Circles

Preliminary Definitions: 1) Space - the name of the collection of cells.
2) Marker - The name referring to crosses and circles.

Axioms: (Axioms will be denoted by A and the number of axiom will be denoted by a small subscript, as A_1, meaning asiom one. A similar notation will be used to denote definition, replacing A with D)

A_3: There are nine cells in the space.
D_1: The cells shall be named 1, 2, 3, 4, 5, 6, 7, 8, 9 as shown in figure 1.
D_2: Corner cell: Cells 1, 3, 7, 9 are corner cells.
D_3: Center-cell: Cell 5 is the center cell.
D_4: Side cell: Cells 2, 4, 6, 8 are side cells.
D_5: Move: Placing a marker in an empty cell shall be a move.
A_4: Moves must alternate between the cross and circle markers.
D_6: Opening move: The first move of a marker in a cell.
A_5: No game may begin with a marker in a cell.
A_6: No cell may contain two or more markers.
D_7: Cross (circle) win: One of the following triples of cells contain all crosses (circles).

(1,2,3), (4,5,6), (7,8,9), (1,4,7), (2,5,8), (3,6,9), (1,5,9), (3,5,7).

D_8: Draw: Neither cross nor circle wins.

A few consequences denoted T_i (i= 1,2,...) are listed that can be proved.

T_1: There are nine opening moves to a game.
T_2: If cross opens, then cross has five moves in the game.

The list of theorems can be very long. There can be theorems that can be proved using theorems previously proved.

Axiomatic Systems-Lesson 2

An axiomatic system, if you will recall, consists of four components; 1) undefined terms, 2) defined terms, 3) axioms and 4) theroems. No axiomatic system may exist without the first three of these components. If care is taken in changing the set of axioms, the axiomatic system will retain its validity and consistency, however, the set of theorems that can be proved will vary if this change is made.

Axiomatic Systems-Lesson 3

An axiomatic system, if you recall, consists of four components; 1) undefined terms, 2) defined terms, 3) axioms and 4) theorems. No axiomatic system can exist without the first three components. A model can be given of the system so that the undefined terms will no longer be undefined. If this is done, a new set of theorems can be proved.

Mathematical Systems-Lesson 1

A mathematical system is an axiomatic system which consists of four basic components; 1) a set of elements, 2) relations among the elements, 3) one or two well defined operations on the elements and 4) a set of axioms which the elements, relations and operations satisfy.

In a mathematical system, the meaning of the elements depend on the example used to illustrate the system. Because more than one example can be given for most mathematical systems, mathematicians view the elements as undefined. The elements can be given different interpretations depending on the model. Different mathematical systems are represented by the integers, the rational numbers and the real numbers.

In a mathematical system, the behavior of the elements under certain operations (addition, multiplication,...) and relations (equality, unequality, ...) is prescribed by a set of authorative statements called axioms. It must be emphasized that axioms are statements of how the elements, operations and relations are to act. The only requirement on the set of axioms is that they yield no contradictory statements when logical conclusions are made applying the axioms. Unfortunately there is no valid general test for consistency of a set of axioms, so the mathematician usually accepts the consistency of a set of axioms if he can find an interpretation of the elements which leads to a model of the system with no contradictions.

In the course of deducing consequences from the axioms, definitions may be introduced when the occasion arises for identifying certain results or terms by name. The axioms, together with the definitions, indirectly imply further properties of the elements. These properties, when of general significance are called theorems.

Mathematical Systems-Lesson 2

A mathematical system, if you will recall, is an axiomatic system which consists of four basic components; 1) set of elements, 2) relations among the elements, 3) one or two well defined operations on the elements and 4) a set of axioms which the elements, relations and operations satisfy. No mathematical system would be complete without these components.

If care is taken in adding axioms to a system, a new mathematical system, having a different set of properties can be formed.

Mathematical Systems-Lesson 3

A mathematical system, if you recall, is an axiomatic system which consists of four basic components; 1) a set of elements, 2) relations among the elements, 3) one or two well defined operations on the elements and 4) a set of axioms which the elements, relations and operations satisfy. No mathematical system would be complete without these components.

If care is taken in selecting the set of elements, a new mathematical system can be formed with a different set of properties.

Instructional Moves: 7CEC; 6C; 6C; 5CEEEC; 6C; 6C.
Control Introduction: none.
Learning Activities: After reading the appropriate organizer, the students worked through self instructional booklets on groups, commutative groups, and cyclic groups. A self-test was included at the end of each booklet.

Hawkins, 1972

Source: ERIC microfiche.
Concepts: niche (for living organism).
Advance Organizer: Students read the following passage.

Human beings have many kinds of activity including eating, playing and working. The term "work" includes such large groups of jobs as unskilled, skilled and professional occupations. Each of these large groups contains smaller groups of jobs. "Professional Occupations," for instance, include lawyers, scientists and doctors. Each individual profession has its own type of work to do: a doctor does not do a lawyer's job and a lawyer does not do a doctor's job. Within the doctor's profession, however, there are many specific jobs which are filled by different kinds of doctors. These individual jobs may be general such as that of the general practioner or specialized such as that of the brain surgeon. Each doctor's job includes what he does, where he does it and the other people (such as nurses, other doctors and patients) with whom he works.

Instructional Moves: C.

Control Introduction: Students read a short story about a boy in a hospital and how the hospital staff helped decrease his boredom.
Learning Activities: The teacher reads a short passage on the concept of niche for a living organism. It dealt with function, habitat, and relationships with other living things.

Hershman, 1971

Source: dissertation - microfilm. The results from this dissertation are treated as three separate experiments. Advance organizers were prepared for three units of instruction. A given group of subjects worked through all three units, but the control and experimental groups were changed for each unit.

Unit II

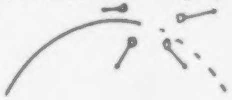
Concepts: newton's second law, momentum, energy, liquids, and gases.
Advance Organizers: Three advance organizers were prepared for this unit. Because of the length of the materials, only the organizer for momentum and energy is reproduced here. The topics covered in the other organizers are described. Students were given the advance organizers and were told to use them while studying. No class time was devoted to them.

Newton's Second Law: It began with a discussion of resolution and addition of vector quantities (displacement, force, velocity, and acceleration). A projectile and an object on an inclined plane were used to illustrate the relationship between force, and acceleration. Several diagrams were included.

Momentum and Energy: The intent of this statement is to aid the student in organizing his thoughts on momentum and energy.

We have learned previously that a vector may be multiplied by a scaler to obtain a resultant vector of different magnitude but having the direction of the original vector. The obtained resultant vector, being a true vector in its own right, may then be added to other like vectors or resolved into components. For example, we may multiply the velocity vector $\vec{V}$ of an object by its mass m (a scaler) to obtain a resultant vector, $m\vec{V}$, called momentum. Similarly the velocities of many objects may each be multiplied by their separate masses and the resulting vectors may then be added by the component method to obtain a total momentum vector, call it $M\vec{V}$, for the system of masses. $M\vec{V}$ is a vector which represents the motion of the system of masses as if it were one mass M traveling with the resultant velocity $\vec{V}$.

Now we may apply the law of inertia to the system of masses and state that the system will continue to move with the resultant velocity $\vec{V}$ unless some external force acts upon the system. Therefore, in all cases where no external forces are involved, the system will move with constant resultant velocity (and also $M\vec{V}$ will remain constant) This does not bar interactions of the separate masses within the system. In fact, the separate masses may collide, stick together or fly apart, and the resultant vector MV will not change. This leads us to the point where we can say that the resultant vectors $m_1\vec{V}_1$, $m_2\vec{V}_2$, etc, may be summed to yield $M\vec{V}$, i.e. $m_1\vec{V}_1 + m_2\vec{V}_2 + m_3\vec{V}_3 + \ldots\ldots = M\vec{V}$ and $M\vec{V}$ is constant in value and direction. Thus $M\vec{V}$,
total momentum, is conserved. An example is a projectile as shown in figure 1 which explodes during its flight. After the explosion the parts will take on velocities such that the motion of the system of parts will follow the original trajectory (consider a Fourth of July rooket in a firewords display.



"Conservation" is a pervasive idea in science. Most of our laws and theories have conservation of something as their base, and the conservation normally occurs in a "system". (A system may be identified with a collection of objects, each of which may have some energy of some form. Energy may appear in many forms--heat, light, electricity, energy of motion, energy of position, etc.) Beginning with a system of things each of which have some energy, no matter what the form of the energy, or the changes of the form of energy, or the exchange of energy between things, the total amount of energy under normal conditions will remain the same, provided no new energy is introduced from outside the system. Applications of the conservation concept that you should look for in the next few recitations are momentum, energy of motion and energy of position.

Liquids and Fluids: The cause of phase changes, and the reduction of pressure in moving fluids were discussed.

Instructional Moves: CCCECECC / CCC; 6CEC / C 5EC; 5C / 4C.

Unit III

Concepts: heat, and waves.
Advance Organizers: Two advance organizers were prepared for this unit. Because of the length of the materials, only the organizer for heat is reproduced here. The topics covered in the organizer for waves are described. Students were given the advance organizers and were told to use them while studying. No class time was devoted to them.

Heat: The intent of the following is to help the student organize his study of heat.

Two characteristics of molecules (or atoms) can be used to explain the concepts of heat we're about to study: (1) molecules (or atoms) attract each other and (2) they vibrate (or move). The amount of attraction between molecules and their relative motions determine the phase of matter that the molecules as a whole exhibit. In a solid the molecules are held in place by strong forces and vibrate to some extent about their central positions. In liquids the molecules are weakly attracted to each other (van der Waals forces) but move freely among one another. In gases there is negligible attraction but a great deal of motion among molecules. Different types of molecules attract each other with different amounts of force. For example, water molecules attract each other with a different force than salt molecules attract each other in all phases. As the amount of motion that molecules exhibit increases, the greater the volume they will need for their motion. As energy (heat) is added to a given substance it will normally expand. This fact when applied to mercury molecules will enable us to make a thermometer where the temperature measures is a measure of the expansion of the mercury due to the added heat.

The amount of energy associated with a given substance depends on the energy of each molecule and the total number of molecules present. If we wish to add energy (heat) to a substance, the more molecules it has the more energy must be added. Also the more energy is added the greater the change in temperature of the substance. Lastly, the amount of energy necessary to affect a certain temperature change depends on the substance in question and its phase. The concept of specific heat embodies these ideas.

When a substance is converted from one phase to another the forces of attraction must be taken into account. For instance, when melting ice, enough energy must be given to each molecule so that it overcomes the attractive forces holding them in place. This indicates that the heat necessary to affect a change of phase depends on the number of molecules present and the force (which differs among substances) of attraction. If we stop adding energy before the ice is melted completely, then we will be in an equilibrium situation where just so many molecules will be supported in the liquid phase and the rest in the solid phase.

Nothing we have said thus far would prevent a molecule of a solid or liquid from receiving enough energy to go directly into the gaseous phase which actually occurs in sublimation and evaporation. Of course, if the external atmospheric pressure is increased or decreased, the amount of energy necessary to sublime or evaporate a molecule will also increase or decrease, respectively. On the other hand, a water vapor molecule may be trapped (condensation) by water if it has lost some energy by radiation or collision. Molecules evaporating and condensing and subliming at the same rate indicate the substance is in a phase equilibrium.

Molecules transfer energy from one to another by collisions. If the molecules in your finger come in contact with the molecules of an exhaust pipe, the molecules in your fingers will vibrate much more rapidly. The greater the surface area of your fingers that touch the pipe, the greater amount of molecular collisions occurring, i.e., the greater the heat transfer. The hotter the pipe, i.e., the greater the temperature difference between the pipe and your fingers, the greater the heat transferred. Finally, the longer your fingers remain on the pipe, the greater the heat transfer.

Heat may be transferred in another manner from one locality to another by actually transporting the energetic molecules, i.e., take the hot exhaust pipe from the car and put it in the horse tank. Hot air carries energy from one locale to another by winds.

Wave Motion: It contained diagrams of sine waves, circular waves, and straight waves, and definitions of wavelength, amplitude, period, frequence, and velocity. Interference, reflection, refraction, and difraction were also defined and illustrated with diagrams.

Instructional Moves: 7CECC / CEECECC / CECCCCEE; E 6C / EC / CCEC / CEE / CECE / CEECE / CECC / CCCE.

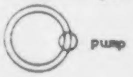
Unit IV

Concepts: electrostatic field and current electricity.
Advance Organizers: Two advance organizers were prepared for this unit. Because of the length of the materials, only the organizer for current electricity is reproduced here. The topics covered in the organizer for electrostatics are described. Students were given the advance organizers and were told to use them while studying. No class time was devoted to them.

Electrostatics: The nature of electrostatic forces and fields was discussed and compared to gravitation. The relationship between the magnitude of the force and the size of the charge and distance was identified. Electrostatic potential and equipotential lines were also discussed.

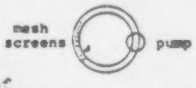
Current Electricity: The following statement is intended to help you organize and relate your study of current electricity to a familiar phenomena.

An electric current in a circuit may be compared to the flow of water in a plumbing system. Consider that a pump is hooked to a system of pipes full of water. Allow all pipes to be on the same horizontal level so that no change in gravitational potential energy occurs. Further assume that the pipes form a complete circuit beginning and ending at the pump and that the pipes are nearly frictionless to water flow.



The work done by the pump on the water would result in the increase in kinetic energy of the water (increase in velocity) with a little energy required to overcome the small friction of the pipes. Thus each time a given amount of water went through the pump it would get a boost in energy (i.e. velocity). But with increased velocity, the frictional heat would increase the temperature of the pipe. This is analogous to (1) the water, (2) the water flow, (3) the pipes, (4) the small resistance of the pipes, and (5) the pump? A difference that may be noted is that the resistance of the pipes is due to friction, whereas resistance in an electrical circuit is due to the collision of electrons with atoms within the wire.

Next, assume that we replace one section of the pipe with one which has a series of small mesh screens in it. Now as the water is circulated, its flow will be retarded due to the resistance of the wire mesh. Therefore, the speed of the water flow will not be as great. Continue to assume no friction in the connecting pipes so that little work is done against friction. Thus once an equilibrium water speed has been reached, no work will be done in these sections of pipe (i.e. no work against friction, no work in increasing its kinetic energy or potential energy). The work that the pump does in moving the water would be equal to the work done against friction in the mesh wire. Also since water is practically incompressible, the work done per unit time by the pump will equal the work done per unit time against the mesh resistances. (Power of the pump = power dissipated in the mesh resistances). Again, see if you can relate this logic to the electrical circuit.



Let us assume the pump gives each unit of water a certain amount of energy which it, in turn, gives up to the wire mesh; and that the rate of water flow is given by the amount of water moved per unit time. If we multiply

$$\frac{\text{amount of energy given}}{\text{unit of } H_2O} \times \frac{\text{amount of } H_2O \text{ moved}}{\text{unit time}}$$

by unit analysis, an expression for power in terms of the "potential" given by the pump and the water flow will result. Do you know a similar electrical expression?

If the number of mesh resistances is increased, less water per unit time will be allowed to flow i.e. the water current is inversely proportional to the amount of mesh resistance (water current $\frac{1}{\text{resistance}}$). But if the amount of energy given each unit of water is increased, we should expect a higher rate of flow for a given mesh resistance (water current $\frac{\text{energy}}{\text{unit of } H_2O}$).
Combining these ideas, water current $\frac{\text{energy/Unit of } H_2O}{\text{resistance}}$
What famous law in current electricity is analogous to this expression.

If we set up many mesh sections of pipe end to end, then their individual resistances would each separately retard the water flow because all of the water must go through each set of mesh screens. This implies that the resistances are additive. Or, if we hooked the resistance sections in "parallel" that proportion of the water moving through each section would be dependent on the amount of resistance it offered. Thus most of the water will move through the pipe that offered the least resistance.

Instructional Moves: 25C; 7C.
Control Introduction: Students were given passages which described the life and work of a scientists who had contributed in the content area to be studied.
Learning Activities: Students attended lectures on the various topics. The lectures made use of frequent demonstrations. Students also attended recitation sessions to discuss problems. Before the beginning of the experimental treatments, all students received instruction on linear motion.

Hoffelder, 1973

Source: dissertation - microfilm.
Concepts: atomic structure, chemical bonding, kinetic molecular theory, properties of matter, solutions.
Advance Organizers: Advance organizers were prepared for four units of study. Students read the advance organizer before beginning work on each chapter. They were allowed to review the advance organizers after work on the corresponding unit had begun. Because of the length of the materials, only one organizer is reproduced here. The topics covered in the other organizers are outlined.

Unit I: Atomic Structure

It discussed the atomic theory and the relationship between atomic structure and the properties of elements. The quantum mechanics of atomic structure was also briefly discussed.

Unit II: Chemical Bonding

We have discussed the structure of the atom and how ultimately the properties of the elements are determined by the electron configuration of the elements. These properties are observed to recur in certain recognizable patterns; we designate these as periodic law.

In nature we also observe a recurring pattern whereby certain elements combine in definite proportions to form new substances, the properties of which are quite different from the original starting materials. The question that follows is "why?" Why do atoms combine? What predictions can we make concerning probable and improbable unions? What do we name the compounds formed from successful combinations? How do we communicate conveniently what has occurred? What generalizations regarding chemical reactions can be proposed? What are some examples of chemical reactions as observed in acid-base chemistry and other basic environmental reactions? The above questions along with certain mathematical competencies--i.e., how to determine an empirical formula, how to compute percentage composition and weight relationships involved in chemical reactions and how to write and balance the resulting equations--shall command our attention in the next unit of study.

The question "why" is a challenge for the theorist. However, an equally difficult assignment awaits the typologist who must classify these compounds when they are formed. The scientist views the numerous compounds relative to each other--that is, grouping the compounds with similar chemical and physical properties and classifying them as to how they react with each other. "Acids and bases" are one of these broad categories or typologies into which certain types of compounds are classified. Traditional acids or bases are further subdivided into "strong or weak" depending upon degree of ionization. As the definitions of acids and bases were expanded from traditional to the Bronsted-Lowry and Lewis concepts, the inclusion of compounds within the major acid-base category became much larger.

You are reminded of the strict adherence to experimental confirmation required of each theory. The fact that definite groups of atoms can and do stay together as molecules under a wide variety of conditions and the fact that these molecules can be identified and often kept indefinitely implies the existence of some kind of binding force between the atoms within a molecule--a force strong enough and selective enough to keep specific groups of atoms together.

Of necessity theories regarding the nature and origin of chemical bonds had to wait until the structure of the atom was more fully developed and accepted. Once the major components of the atom, their relative positions and characteristics were determined observations concerning bonding could be considered. The specificity of chemical reactions, the laws of definite and multiple proportions, the empirically determined properties such as bond strength and bond length were among the contributors to bonding theory. Covalent and ionic bonding were proposed--the major force in both types being the electrostatic interactions between the atoms which resulted in a lowering of the potential energy and therefore the total energy of the system. Current approaches to bonding include the valence bond theory, molecular orbital theory and hybridization theory; each has made unique and valuable contributions to the whole of bonding, but no one theory has as yet to answer completely the ultimate criterion against which it must be measured.

Making, separating and identifying molecules, discovering what they will do and (in as much as possible) why--these constitute necessary steps in the production and utilization of new materials. The plastics, dyes, preservatives, pesticides, artificial flavorings, medicines--all of which are a part of our daily world are the results of man's application of the knowledge of the properties and reactions of atoms and molecules.

Unit III: States of Matter

The kinetic molecular theory was discussed in relation to the behavior of ideal gases. The physical and chemical properties of a number of specific substances were discussed and related to the usefulness of the materials in industry.

Unit IV: Solution Chemistry

Solutions were defined and distinguished from colloids and suspensions. Several practical applications of solution chemistry were discussed. The raising of boiling point, lowering of freezing point, and depression of vapor pressure were discussed briefly.

Instructional Moves: CCCEECC / CEECEEC / 5C; 5C / CCEECCEEEC ; 7C / CEEEECE ; 9C / ECECCEEEE.
Control Introduction: Students in the control group studied while the experimental group read the advance organizers.
Learning Activities: Students attended lectures and participated in laboratory work.

Hysell, 1973

Source: The materials were not obtained. Hysell was contacted but did not respond.
Concept: points of focus as a means for the systematic descriptive analysis of art work.
Advance Organizer: Students read a passage which described and explained "points of focus" in the aesthetic analysis of art work. The points of focus are the idea expressed through subject mater and other visual symbols, formal organization of visual symbols, and sensuous materials and their manipulation. Students were given the opportunity to apply this method in exercises.

Control Introduction: none.
Learning Activities: Students worked through programmed instruction on the analysis of art work.

Jerrolds, 1967

Source: dissertation-microfilm.
Concept: counterespionage.
Advance Organizers: Two advance organizers were prepared. One was a single sentence and the other was a longer passage. Students read one or the other.

Spies and Counterspies

The counterspy protects his country by determining in advance what information enemy spies want and by taking appropriate steps to keep that information from the enemy.

Spies and Counterspies

Almost all nations in the world today are concerned with spying and counterspying. Even those small nations, which look to larger nations for protection, must cooperate with their protectors in the two operations of spying and counterspying. Every nation has enemies, internal and foreign. In every nation there is also information which, if allowed to fall into the hands of those enemies, could lead to the destruction of that nation.

Most of us know a great deal about spies and the ways in which they operate because they are popular subjects for books, television and newspapers. We may define spying as getting secret information, about an enemy or possible enemy, which might be used against that enemy or other enemies. The collection of information openly is not considered to by spying. Foreign consulates and embassies have always collected information: they are expected to do so. If the people in consulates and embassies, however, resort to secret or illegal methods of collection or information such as bribery, theft, blackmail, or wiretapping, they automatically are spies.

The work of the counterspy is not nearly as well known as that of the spy. Counterspying includes all measures taken to keep an enemy or possible enemy from spying or otherwise damaging or weakening a country. Counterspying is a protective and defensive operation. Although the purpose of counterspying is defense, the methods used by counterspies are mainly those of offense.

There is no international law against spying, only national ones, therefore, laws and regulations governing both spying and counterspying vary from country to country.

The information needs of a country are decided upon at high levels of the spy organization or by government leaders. The individual spy does not know the overall spy operation. He is simply ordered to collect certain information or kinds of information. He may have training, but in many cases he is left on his own to decide how to get the information. He has as little contact with his employers as possible. The spy may volunteer information he has not been asked to get, but he is in no position to judge the value of that information.

The counterspy must find out what information the spies are seeking and who the spies are. The counterspy is almost always trained for his work and is in frequent contact with his headquarters. His headquarters generally issues detailed orders to him as to what and when to investigate, whom to contact, and what to do with the spy once he has been identified. The aims of the counterspy are to locate, identify and neutralize the spy network. To neutralize the network means to make it ineffective whether or not it is destroyed.

Many spies are carefully trained. Since the counterspy's job is to prevent spying, he must have much of the same training that the spy has, otherwise, the counterspy would not know how the spy would or could be operating. The spy knows that the counterspy will catch him if he does not change his techniques of operation so he constantly does so. The counterspy is constantly trying to learn the latest methods of operation of the spy.

Often the collection of secret information is easier than getting it back to the country the spy is working for. The counterspy knows that fact. The counterspy thus works from two different angles; he tries to keep secret information safe, and he tries to cut out the channels of transportation between the spy and the country the spy works for.

Instructional Moves: 2C; 13C.
Control Introduction: none.
Learning Activities: Students read a short passage on counterspionage.

Jones, 1974; 1977

Source: dissertation - microfilm.
Concept: feedback in a systems approach model.
Advance Organizers: Two advance organizers were prepared. The abstract version was designed for high-ability students and the concrete version was designed for low-ability students. Students observed a tape-slide presentation of one of the organizers. An asterisk (*) in the following text designates a change of slides during the presentation.

Abstract Advance Organizer

Earlier we learned how to use the systems approach as a method to analyze specific problems. We learned that a systems viewpoint using an input-output model has broad applications for the study of natural and man-made systems.* You may recall this model of a system used to supply fish for food. Each input into the system has some effect on the system which in turn effects the output (in this case the supply of fish for food).

We will now consider another aspect of the systems approach where a system's output* becomes a part of the input. This new element of input is referred to as feedback.* Feedback engineering is a major part of technology.* It allows the system to exhibit purposeful behavior as opposed to mechanistic behavior.* Without feedback, the supply of fish for food system we looked at earlier continues the same operation even when production falls off.* Awareness of this deficiency--a form of feedback--may lead to changes in other inputs to again optimize production. In this case, it might lead to a chemical analysis that indicates we need to decrease pollution.*

When feedback is utilized, a system or a machine is permitted to display goal seeking characteristics.* The general goal of a feedback system is the elimination of error. The use of feedback involves the addition of an important component to the system--a comparator.* The comparator compares a system's output with its goal.* Its reasoning may be described mathematically as follows. If we let X = inputs and Y = outputs, then Error may be described as $X - Y$.* If $(X - Y)$ is very small, then goals are realized and changes in the system input are uncalled for.* If $(X - Y)$ is large, the comparator indicates that input must be changed in some positive manner.* This allows a system to become automatic, permitting control over unwanted inputs.*

A modern electric power plant can provide hundreds of examples of feedback automatically controlling the decision-making process.* While it is operating and synchronized with the distribution system, this steam-driven turbine-generator must continually rotate exactly sixty times each second.* One turbine-generator rotating a little faster or slower than 60 revolutions per second (rps) would cause serious electrical disturbances, perhaps even blackouts.

Maintaining the goal of sixty rps would be a relatively easy accomplishment if the amount of power required by customers remained constant. But, as you know from your own homes, this is not the case.* We want lights and appliances to operate only when we need them; and we want to conserve energy by shutting them down when their use is not required. When the lights in this room are turned on, power is drawn from the system.* This means that more energy is being put out by the generator in the form of electricity* than is being received by the turbine in the form of steam. The immediate tendency is for the turbine-generator to slow down (just as you would if your daily output of energy exceeded your intake of nourishment). What must happen, then, to keep the turbine-generator from slowing down?* To answer this question, let us look at a diagram of our system.

The goal of this system is for the turbine-generator to maintain sixty rps. Feedback allows the comparator to sense and "learn" the direction and magnitude of any error.* The comparator sends signals to the controls that regulate steam flow.

As an example, let us make the assumption that our act of turning on the light pulls enough power from the distribution system to slow down the turbine-generator. What happens to the system? First the system output is registered as too low. Feedback relays this information to the comparator which computes the error from the desired goal.* A signal caused by this imbalance orders the valves that control steam flow to allow more high pressure steam to deliver its energy to the turbine* which in turn, has its rate of rotation increased.* If feedback is continuous and the controls operating smoothly, our output should increase rapidly and methodically.* As the output approaches 60, this feedback too is utilized so that any decrease in steam valve opening necessary for a smooth return to the desired goal may also be effected. Other disturbances would be compensated for in a similar manner as is shown on this recovery graph.* Of course, in this example, feedback has been continuous and the system has approached perfection. Sometimes instability accompanies feedback.* If the turbine-generator system received feedback only once every one-half minute, its disturbances recovery graph might look like the second curve.* If feedback is continous but the compensating controls sluggish, the disturbance recovery graph would look more like the third. If we have both intermittant feedback and sluggish controls . . .* well, things might get just a little bit "wild." Perhaps you can see that it is easier for a system to maintain its goals when feedback is continuous and response is instantaneous.

The system we have investigated is actually a small part of a much larger network of interconnected systems where feedback takes many forms. As more steam is supplied to the turbine, the steam pressure in the boiler is decreased. This information serves as feedback to a system with the goal of a constant boiler pressure. Its comparator then calls for more water to be pumped into the boiler. This water is relatively cold causing the steam temperature to drop.* This temperature decrease serves as feedback to a system with a goal of constant steam temperature. Its comparator calls for more fuel to be burned. The subsequent opening of fuel valves causes fuel oil pressure to drop.* This information is feedback to a system whose goal is a constant fuel oil pressure. Its comparator orders fuel pumps to work harder or calls for more pumps to begin operating to keep fuel oil pressure up. Whew! We could go on and on like this for the rest of the day, but perhaps you get the idea!

*We have seen how the behavior of a system can be made purposeful (that is, guided by desired goals) rather than mechanistic (governed only by past causes). Your understanding of other feedback systems will be enhanced if you take the time to ask yourself three questions.

*1. What is the goal of the system?
2. What does the system's comparator "learn" from feedback and how does the system's comparator change the mathematics of analyzing the system?
3. How does this help the system approach perfection?

Concrete Advance Organizer

Earlier this year we learned how to model something from the real world and how to use the model with a systems approach. As you may recall, a systems approach model looks something like this. A system has both input and output.* Many systems have a large number of each. Often man is concerned with a system with several inputs and only one important output.* A modern egg farm is such an example.* Inputs would include hens, food, water, energy and maybe you could think of more. The output, of course, is fresh eggs.* The farmer hopes to optimize his egg production by carefully controlling the inputs. Too much or too little of any item may cause his system to produce fewer eggs.

We will now add something else that will make it easier for a system to reach its goals.* The new addition will be called feedback. Look at the word and see if it suggests a meaning to you.* Well, this isn't exactly it.* And neither is this!* Feedback represents a major change in our model of a system. When it is used, the output becomes a part of the input; you might want to think of it as output that is recycled. Knowledge of how the output compares with the goal of the system is provided by feedback.* For our egg producing system knowing how many eggs are produced each day is the feedback.* Without feedback the farmer would not know if the goal was being reached. If the actual output was much less than the goal (and there was no feedback) the farmer would not know that the system was not optimizing. He would not know that the inputs need to be changed.* By counting his eggs every day he can add feedback to the system.* Each feedback system has a comparator. Its purpose is to determine any error between actual output and the system's goal. Feedback, then, adds learning to a system.* As long as the output is close to the goal, error is small and there is no need to change the input.* When error becomes large the system can realize that the output is much different from the goal. The amount of error, then, determines if the input needs to be changed before goals can be reached.

*As you can see, the use of feedback has added some important advantages to our use of a systems approach. It allows the system to seek a goal, to learn if the goal is reached, and to make the system more perfect.

This man is adjusting the flame level in his home furnace. Experience has helped him to learn about how much flame will give enough heat to insure a comfortable night's sleep. Sometimes he makes a good guess, but what happens when an unexpected winter storm moves in during the night? *There was not enough heat, the house is cold, and everyone wants a spot next to the furnace. It could also work the other way.* Anticipating a cold night, the man adjusts the furnace for extra heat.* If a warm front moves in instead, the room temperatue could soar to a very uncomfortable level.

Let us look at a model of this system. Of the inputs, the man can control only the amount of fuel being burned. The other inputs may be considered outside disturbances. If the outside temperature or wind speed (or both) change in a manner that was not predicted, the house may be too cold or too hot. Here the lady of the house suggests that the man of the house do something about this situation (it looks like Dad is getting some feedback.)* So he modifies his heating system to include thermostatic control. You know, set it at a desired temperature and forget it! How does this change the system? *The thermostat is the comparator. It receives feedback information about the room temperature. The outside disturbances are still there but as they change, feedback can control their effect. Can you see how it can be used to make a system operate automatically?*

This three-year-old girl has been asked to ride her tricycle keeping the front wheel on the line.* By watching the front wheel and the line, she can operate with continuous feedback* and does pretty well.* Here is a trace of her path. What happens when feedback is not continuous?* Here she is blindfolded (interrupting her feedback) and allowed to see where she is only after every time she completes five pedals.* Oops! *Now we're on the other side, *pretty good anyway! *Here is a trace of this trip. *Let's do it again, only this time she will get to peek only after every ten pedals. *Uh-oh! *Well, we'll fix that! *How'd I get way out here?* Again!* See how the three paths compare? Perhaps you can see some advantage to continuous feedback.

We have seen how a system can be made to learn, to seek a goal, and acquire perfection with the addition of feedback. During the next few days you will see some examples of feedback. They will be easier to understand if you try to answer three questions about each:

1. What is the goal of the system?*
2. What does the system "learn" from feedback?*
3. How does learning from feedback help the system to become more perfect?*

Instructional Moves: CCECCECCC / CECCECC / CE 6C / ECC / ECC / ECC / CCC; CEECCECCE 6C / EECCC / EC / EC / ECC / CCC.
Control Introduction: Students observed a tape-slide presentation which made reference to the concept of feedback and gave some examples, but did not explain how feedback mechanisms work.
Learning Activities: Students participated in classroom instruction and laboratory activities on feedback mechanisms.

Kahle, 1971; Kahle and Nordland, 1975

Source: dissertation - microfilm.
Concept: energy matter relationships.
Advance Organizer: Students listened to an audio tape of the following passage. Materials were provided for the activities described in the passage.

Energy for Life

Some day your hope to teach in an elementary classroom. One of your first and last observations will probably be of the unlimited energy of your youthful charges. But what is energy? It is difficult to define: for unlike matter energy neither occupies space nor has weight.

Notice the pecans in your carrel. Right now they have potential, or stored energy, later that energy may be changed to kinetic energy, or energy of motion. Energy is constantly being changed from potential to kinetic and back again. This phenomena is basic to life: for the potential energy of food is eventually changed to the kinetic energy of muscle contraction, transmission or nerve impulses, or other biological functions. In addition to the two kinds of energy, potential and kinetic, five forms of energy are recognized, and these forms are inter-related and interconvertible. In fact, conversion of energy from one form to another goes on continually. Let's try to demonstrate some conversions.

In the carrel you should find a cork stopper with a pin in it, matches, a spoon, and a beaker of water. First, eat a pecan half. As it is chewed, digested, and assimilated, energy changes occur. Now place another half of a pecan on the pin, leaving it as near the tip of the pin as possible. In a minute I want you to stop the recorder and light a match, holding it below the pecan until the pecan is flaming. You may have to use several matches; but when it is flaming, return to the recorder. MUSIC

Is the pecan flaming now? What forms of energy do you observe as the pecan burns? PAUSE Now pour some water into the spoon and hold the spoon near the tip of the flame until the pecan is entirely burned. You may stop the recorder to do this and return as soon as the pecan is completely burned. MUSIC

Is the fire out? PAUSE Let's examine the ash of the pecan, the bottom of the spoon. PAUSE What happened to the water in the spoon? Is there any evidence of transforming or changing, energy from one form to another? PAUSE The pecans contained potential energy in the form of chemical energy. Unless you found it absolutely necessary to boil the water or produce light, the energy stored in the pecan was of little value when it was transformed. The important point for us, however, is that the heat and light energy liberated are evidences of the fact that energy was somehow contained in the pecan.

What about the pecan that you ate? What happened to it? Let's postpone this problem for the time being and consider a problem of how the energy is stored in the pecan, or in the food you eat, or in matter. What is the nature of matter that enables it to store energy that can be released? We'll study this problem for the next month for it is basic to much of biology.

Instructional Moves: ECC / EECCECC / 5EC.
Control Introduction: none.
Learning Activities: Students worked through an audio-tutorial unit on the electronic nature of matter which covered static and current electricity and atomic structure. Behavioral objectives, laboratory activities, slides, self-tests, discussion groups, and oral quizzes were included.

Kahle and Rastovac, 1976

Source: Materials were not obtained. Kahle was contacted, but did not respond.
Concepts: metosis, meiosis, and chromosomal aberations.
Advance Organizers. Advance organizers were prepared for each of three units. They were presented to the students via audio tape prior to each unit. The specific content of the advance organizers was not described.

Control Introduction: Students listened to audio tapes of historical introductions. The specific content was not described.
Learning Activities: Students worked through audio-tutorial units on metosis, meiosis, and chromosomal aberations. Behavioral objectives, study guides, visual aids, laboratory materials, and quizzes were included.

Kennedy, 1974

Source: dissertation - microfilm.
Concept: units of measurement.
Advance Organizer: Students read the following passage.

Four fifth grade students, Carol, Valerie, Steve, and Frank, were comparing heights. They marked points on the blackboard corresponding to the tops of their heads. Not having rulers, they decided that each person would measure his own height using the span of his hand as the unit of measure. They obtained the following results:

Name:	Carol	Valerie	Steve	Frank
Height:	8 spans	6 spans	7 spans	7 spans

The results were surprising to the children since Carol was the shortest of the four. They cediced that they should have had all of the heights measured by the same person. When Carol measured the heights, she obtained the following results:

Name:	Carol	Valerie	Steve	Frank
Height:	8 spans	9½ spans	10 spans	9 spans

When the children told their teacher what they had found, she gave Frank and Valerie one ruler and Carol and Steve another ruler. She then asked each pair to measure their heights using the rulers they had been given. They wrote the results on the board in the form of a table that looked like this:

Name	Frank & Valerie	Carol & Steve
Carol	40	102
Valerie	47½	121
Steve	50	127
Frank	45	115

The children examined their rulers carefully because the results were very confusing to them. Frank and Valerie found that their ruler was marked off in English units, that is, in inches, while Carol and Steve found that they had a metric fuler marked off in centimeters. When they compared their rulers, they found that 1 inch was equal to 2.54 centimeters and that 100 centimeters, which the teacher told them was called a meter, was the same as 39.36 inches.

The children summarized the relationship between the English system units of length and the metric system unit of length using a graph. The results are shown in Graph 1.

Having become interested in the metric system, the children summarized the relationship between the English system and metric system units of weight in Graph 2. Graph 3 summarized the relationships between the units of liquid capacity.

Note: The three straight line graphs showed the relationship between inches and centimeters, pounds and grams, and fluid ounces and millilitres.

Instructional Moves: ECEEC 5E.
Control Introduction: Students read a passage on the history of the development of the metric system.
Learning Activities: Students attended classroom instruction and did laboratory work using metric units of measurement.

Kersten, 1976

Source: dissertation - microfilm.
Conepts: mathematical systems, and matrices.
Advance Organizer: Students read a passage on mathematical systems and matrices. Because of the length of the passage, only part of it is reproduced here. The first part of the advance organizer covers mathematical systems (operations and the properties of addition and multiplication on real numbers). The properties of an algebra (a ring that is a vector space over a field) are also discussed. The last part of the advance organizer which is reproduced below converse metrices.

The set of square matrices of the same size also form an algebra. It should be of interest to compare the properties of matrices with the familiar properties of the real numbers. There are obvious similarities between these sets of elements and their properties. But there are also some striking differences between the two systems.

A matrix is an array of real numbers which are arranged in rows and columns. Matrices are typically denoted by capital letters like A, B, C. The size of a matrix is the number of rows and columns that are in the matrix. The operations of addition and multiplication are defined on the set of matrices in a way that not all matrices can be added to each other and not all matrices can be multiplied together. Square matrices of the same size can always be added together. Addition is commutative ($A + B = B + A$), associative $(A+B) + C = A + (B+C)$, has an identity element, and each matrix has an additive inverse. All of these things are just the same as they are for the real numbers.

For square matrices of the same size multiplication is also always possible. Multiplication of matrices is associative $(AB)C = A(BC)$ and the distributive property holds $A(B+C) = AB + AC$ and $(B+C)A = BA + CA$). Therefore, square matrices of the same size form a ring. Multiplication of matrices, however, is not in general commutative. That is, there are matrices such that $AB \neq BA$. This is completely different from how real numbers behave. Also, there does not exist a multiplicative identity that works for all matrices, although there does exist one for square matrices of the same size. Lastly, multiplicative inverses do not exist for all nonzero matrices which is different from the situation in the real number system.

The real number system has two basic operations, addition and multiplication. The system of matrices, being an algebra, has three basic operations: addition, multiplication, and scalar multiplication. Scalar multiplication with matrices is an operation between the set of real numbers and the set of matrices. If f and g are arbitrary real numbers, then scalar multiplication with matrices has the following properties:

1. $f(A + B) = fA + fB$.
2. $(f + g)A = fA = gA$.
3. $(fg)A = f(gA)$.
4. $1A = A$

Notice that properties 1 and 2 are similar to the distributive property of multiplication with respect to addition for real numbers and that property 3 is similar to the associative property of multiplication for real numbers. However, in these properties A and B are matrices rather than real numbers. Lastly, since square matrices of the same size form an algebra $f(AB) = (fA)B = A(fB)$ where f is an element of the real numbers and A and B are square matrices.

When you study the matrix system the ideas presented here should be of value to you. Keep in mind the structure of an algebra and the similarities and differences of this structure when compared to the real number system.

Instructional Moves: ECCECC / E9C / EC / E11CEC / 7CEEC / CCECEC / 24C.
Control Introduction: Students read a description of the lives of Arthur Cayley and James Sylvester who contributed to the development of matrix theory.
Learning Activities: Students worked through textural materials on matrices.

Kirkwood, 1970

Source: dissertation - received through inter-library loan from Purdue University, Indiana; also available on microfilm.
Concepts: mass production.
Advance Organizers: Separate advance organizers were prepared for three lessons. Students read the appropriate passage before each lesson.

Lesson One Organizer

The era of mechanization which extended from the latter half of the nineteenth century to this decade was a period of unprecedented growth in population and wealth. Both of these factors created a greater demand for more and more goods of a similar nature which could be manufactured more economically be mechanized processes. But mechanization required large capital outlay for expensive equipment. Even so, the market justified the unparalleled rise of huge industrial enterprises equipped to create goods by mass production.

Mass production is a gradual process of development and refinement of the production principles of speed, power, accuracy, system and economy. Achieving these principles is a result of doing things faster, creating and utilizing new sources of power, developing new concepts and methods of measurement, instituting new methods of production and new environments for production, and of ensuring a healthy economy to provide consumers. Progress is dependent not only on invention and refinement of machines and tools, and on discovery and improvement of materials and processes used in producing goods which are in sufficient demand, but also on efficient management of an economically planned industrial enterprise.

Progress in mass production was made possible by the worthy contributions of the machine-making industries. In addition to making general machine tools, they also manufactured specialized and diversified mechanical equipment required for producing and assembling interchangeable parts. This equipment included such items as special purpose tools and automatic machines which were located in a position necessary for performing successive operations as the material passed from work station to work station.

The systematic method of assembly was another innovation that improved the mass production system. By organizing work stations along an assembly line, all the various parts going into a mechanism were brought together at proper locations along the assembly line and were fitted into the partially assembled mechanisms as it came from other assembly lines. This technique proved to be an economical means of assembling mechanisms composed of a large number of parts.

Lesson Two Organizer

The tremendous increase in productivity and the resultant high standard of living which we now enjoy can quite accurately be thought of as having its start in the Twentieth Century. The foundation for producing large quantities of identical goods already existed in the techniques developed by Whitney and in the mechanical inventions and innovations following him. However, the stimulus for the present-day organization of industrial methods and procedures did not exist until the turn of this century. It remained for several men with a great deal of organizational ability and foresight to recognize both the need and the means of producing large quantities of goods. This came about following the invention of the automobile at the turn of the Twentiety Century.

To produce the automobile in quantities whereby the price would be low required many things. It required that new factories be built, new methods for the utilization of skilled, semi-skilled and unskilled manpower be found and new concepts in the production of goods be found.

The principles developed by the automobile industry were rapidly put into practice by other industries. In less than 40 years American industry had developed these new methods, manpower and concepts which were necessary for the production of a large variety and quantity of goods. The practicability and universality of the American system of production can easily be illustrated. The automobile industry among others loses little production time in making yearly model changes. Further the United States has shown its ability to convert almost instantly from the production of peace-time goods to the rapid production of precise and accurate war goods.

National emergencies of many kinds also provide industry with more incentives to increase production rates through the application of existing principles to a large variety of new problems. In the solution of these new and often critical problems, new principles become apparent which aid in the production rates, in the quality, and in reducing the cost of the product. These new principles are also applied by industry to other goods when these emergencies have been resolved.

Today's lesson is concerned with the development of the automobile industry. This industry is chosen as an example of American industry since it has pioneered so many of the principles of production, and because it is somewhat familiar to most people. The lesson covers the time period from the start of the Twentieth Century to the present. The previous lesson presented the concept of mass production as the production of identical, interchangeable parts. It differentiated between this concept and the common oversimplified one of mass production as the production of large quantities of goods. This more inclusive concept leads us directly to the concepts under study today. Today's lesson will discuss the present-day methods and techniques of production related to specialized tasks, machines, methods, materials and management.

Lesson Three Organizer

The high standard of living which most Americans now enjoy is measured by the amount and quality of goods which are consumed by the majority of the people. The abundance of goods necessary for this high standard of living is a direct result of our techniques of production. These techniques of production which were discussed in the last lesson are quite complex. Today's lesson will show the complexity and intricacy in more detail, and will expand the concept of production to include the activities which precede and follow the production of a product.

Any undertaking requires a great deal of preparation. First, the basic idea must be conceived. This is usually based upon some perceived need, whether it be a personal need, a social need, an economic need, or any other need. The need is based upon the solution of a problem which is imposed by the environment. Once the problem and the need are perceived, methods of attack upon the problem and tentative solutions are developed by the individual or group which is attempting to solve the problem. The entire creative process from perception to the arrival at a tested and proved solution is quite evidently a complicated process. Further, there is a strong interrelationship between the various stages of the creative process. This is true of manufactured products, artistic creations, and even daily living.

There are other aspects of complexity which are encountered when attempting to produce a product. Complex undertakings require many variations in the depeloyment and utilization of materials, people and systems. It is necessary that materials be procured and sources of supply be identified. It is necessary to identify and obtain the properly trained people for the various jobs and positions. Systems must be developed in the deployment of materials and people. The organization of these elements becomes a major problem when they are all prqsent, especially when the solution involves concrete materials.

A unifying element is needed to coordinate all activities from the design stages through to the marketing of a product. In any industrial enterprise, this is the function of management.

The function of an idea in an industrial enterprise is the final, marketable product. Although the most spectacular and the most well-known aspect in the production of a product is the final assembly, it is not the sole function of any industry. It is simply the last step in a complicated process.

Instructional Moves: 13C; CCCCE 6CECCECCC; 13C.
Control Introductions: Students read passages dealing with the impact of technology on society and the importance of studying technology in school.
Learning Activities: Students attended classroom instruction on conditions resulting in the development of mass production techniques, procedures used in mass production, and its impact on society. Several examples were discussed and overhead transparencies were used.

Koran and Koran, 1973

Source: Materials were not obtained. John Koran was contacted but did not respond.
Concept: insects.
Advance Organizers: Two advance organizers were prepared for the same learning passage. They presented the idea that insects can be studied on the basis of body structure and function, lifecycle, or social organization. In one of the advance organizers, examples were added to illustrate this idea. Students read the passages.

Control Introduction: Students read a passage outlining man's attempt to control insects.
Learning Activities: Students worked through a programmed instructional booklet on insects.

Kuhn, 1967; Kuhn and Novak, 1970; Kuhn and Novak, 1971

Source: dissertation - microfilm (Kuhn, 1967).
Concept: dynamic equilibrium.
Advance Organizer: Students read the following passage.

Homeostasis (Dynamic Equilibrium)

The ability to maintain relatively stabilized internal conditions, even when under stress, is called homeostatic regulation, or more simply homeostasis. The stabilized or steady state conditions that are maintained through homeostatic regulation are key factors in the ability of living organisms to survive.

A fundamental trait of homeostatic regulation is that it is self-regulating; that is, it possesses the ability to make corrections for deviations from normal conditions. Sometimes the self-regulatory mechanisms which accomplish homeostasis are obvious. If the dog becomes too warm, it will probably awaken and move to a more comfortable spot in the shade. This movement is obviously a form of regulation, involving activity of the brain.

Homeostatic regulation is present on all levels of life from the molecular to the community levels. The regulatory mechanism functions in much the same manner at all the levels with the degrees of complexity being different.

Picture in your mind the image of a ten year old boy attempting to walk along the top of a fence. This may help you understand homeostasis better. As the boy slowly moves along the fence, his brain (this regulator which receives messages and sends them is known as a modulator) is continually receiving messages (feedback) from his eyes, ears, etc. The information sent through this system keeps the body informed of the position of his body in relation to the fence. Any tilting or swaying by the boy results in feedback information that the brain analyses in order to issue messages to the parts of the body that carry out activities, (the muscles or glands). After continued practice, he may eventually become quite skillful and be able to walk the entire fence with very little swaying; then it can be said that he has achieved a homeostatic relationship. Therefore, the concept of homeostasis is based on the ability of an organism for self-regulation by making corrections for deviations from normal conditions.

The principle of dynamic equilibrium (balance) can be illustrated by a single analogy. If one compares the organism and the cells that compose it to the flow tank in Figure 1, certain similarities to the dynamic balance of the living system may be noted in the workings of the tanks.

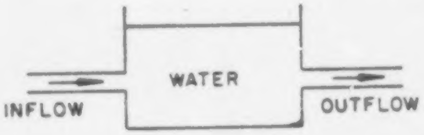


Figure 1

If the amount of water entering the tank is just equal to the amount of water leaving it, the water level will not change and such a system is said to be actively balanced. The circus juggler who maintains an active balance as he juggles several objects keeps them in dynamic equilibrium. Our body processes are regulated so that many such dynamic equilibria are maintained.

Remember that the flow tank is in dynamic equilibrium only when the inflow is equal to the outflow. To arrange a system in dynamic equilibrium, you must regulate either the inflow or the outflow, or both.

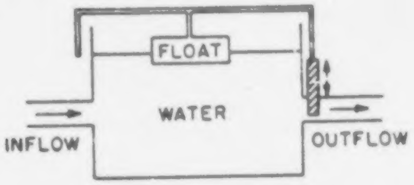


Figure 2

Figure 2 issustrates a simple mechanical model that could be used to regulate the outflow. The outflow would increase when the amount of water entering is increased. If this regulation device operated fast and effectively enough, it would keep the level of water in the tank nearly constant.

In the living organism both the inflow and outflow of the blood glucose (sugar) must vary a great deal from time to time depending on the activity of the body cells, the chemical composition of the food, and many other factors.

The regulating devices that maintain constant concentration in the blood are very complicated. The regulation of a body function such as glucose regulation is much more complicated than the single flow system illustrated by the diagram. Yet, like the flow system, all the mechanisms that regulate the glucose concentration are likely to depend on the glucose concentration itself.

The simplest type of homeostatic regulation is through thermostat-like action. A thermostat-like regulator is one which causes any variation from an acceptable range to trigger a corrective measure and bring the activity back into the range. A physical model for the thermostat-like regulator may be found in the heat-controlling device in our homes. The action of the home thermostat causes the completing or breaking of an electrical circuit. When the circuit is completed, the furnace goes on and the temperature rises. When the circuit is broken, the furnace turns off and the temperature falls. Can you think of an activity in the human body that functions in a somewhat similar manner?

The second type of homeostatic regulation is through the use of feedback action. A feedback regulator is one in which the accumulation of an end product of the system inhibits (slows) the initial reaction e.g. the accumulation of a hormone in the blood would eventually slow up its production by affecting the glands that produce it.

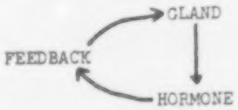


Figure 3

In more complex systems, it is also possible that feedback action may have a stimulating effect (positive effect) e.g. an increase in hormone A production by Gland I may influence Gland II to produce more of hormone B.

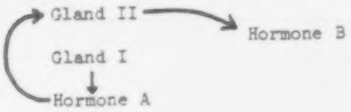


Figure 4

Instructional Moves: CCCECECC / ECEE / CECEC / CEC / CECEC.
Control Introduction: Students read a historical passage on the derivation of the term homeostasis with reference to the scientists who introduced the term.
Learning Activities: Students read materials and did laboratory activities on the homeostatic systems which control body temperature, hormone production by various glands, and heart beat.

Lawrence, 1970

Source: dissertation - microfilm.
Concepts: causes and effects of pain, pain detection mechanisms in the human body.
Advance Organizer: Students read a passage. Because of its length only part of the advance organizer is reproduced here. The first part of the advance organizer covered causes of pain, effects of pain in humans, and ways in which humans deal with stress (repression, supression, rationalization, etc). The portion of the advance organizer given below coveres the anatomy and physiology of pain.

There are two general types of pain: (1) somatic which pertains to the body surface or the structures of the body wall and (2) visceral which pertains to the organs. The receptors for pain (nerve endings of the afferent sensory nerves) are FREE NERVE ENDINGS. The receptors are scattered throughout the body and it is estimated that there are several million of them. The afferent pathways for somatic pain consist of fine myelinated (covered with a fat-like sheath) and unmyelinated fibers in the cranial and spinal nerves. The ascending tracts, lateral spinothalamic, in the spinal cord are most important. They convey stimuli of pain and temperature. The lateral spinothalamic tract originates in the posterior portion of the posterior cell column, crossing to the opposite side in the anterior commissure and then ascending to the thalamus in the lateral funiculus. Injury to the lateral spinothalamic tract results in the loss of pain and temperature sensation on the opposite side of the body. By various relays, pain impulses reach the thalamus, which is a large rounded mass of gray matter in each cerebral hemisphere lateral to the third ventricle. The thalamus is composed of many nuclei and relays afferent impulses to the cerebral cortex.

The sensory area for the discrimination of somatic pain is thought to be in the pariental lobe of the cerebral cortex. However, when the parietal lobe of the cerebral cortex is stimulated in the conscious patient during brain surgery, he does not report a sensation of pain. Crude sensation of unlocalized pain and temperature may be experienced in the thalamus. The fear and anxiety, usually associated with pain, probably are experienced in the prefrontal cerebral cortex.

ADAPTATION to pain does not occur. This is particularly important since pain is a warning signal of danger. If an individual became adapted to pain and therefore ignored it, continuing damage would occur.

Visceral pain results from stimulation of receptors located in the viscera. Impulses are conducted from these receptors to the spinal cord by primarily the sympathetic fibers, and only rarely by the parasympathetic fibers. Stimulation of these receptors produces impulses that eventually reach the brain and produce a skeletal muscular reflex, a visceral reflex, and/or the sensation of pain. An example of a skeletal muscular reflex or a somatic reflex is the reflex muscular rigidity of the abdominal wall which accompanies appendicitis. An example of the visceral reflex is the reflex secretion of mucus when the large intestine is distended. An example of the sensation of pain is the experiencing of pain due to an irritating substance in the stomach.

The impulses that give rise to the sensation of pain require further discussion. The afferent neurons, that conduct the impulses from the receptors in the viscera to the spinal cord, come in contact with second neurons in the spinal cord whose axons form the lateral spinothalamic tracts. Some of these impulses, such as those from serous membranes, have a private pathway to the brain somewhat like a private telephone line. Others being on a party telephone line must share the second neurons with impulses from cutaneous areas. Hence, the axons of the second nuerons do double duty by conducting impulses from visceral pain receptors and from cutaneous pain receptors to the same areas in the thalamus and the cerebral cortex. This arrangement is known as CONVERGENCE.

When there is a private line to the cerebral cortex, pain can be localized accurately. One of the best examples is the patient with pleurisy. He can point to a certain area where he has pain; and the physician will hear a friction rub over this area, meaning that the pleural membranes are inflamed in this particular spot.

When there is a party line, the sensation of pain is aroused in the brain; but it is perceived as occurring in the cutaneous area from which impulses come to the same area in the brain. This happens because cutaneous pain is of more frequent occurrence than visceral pain. This phenomenon is called REFERRED PAIN. Referred pain means that pain from a viscus is referred to a related cutaneous area. The cutaneous areas to which visceral pain is referred are of great diagnostic importance. Common examples of referred pain are the patient with angina pectoris (which is due to a lack of oxygen in the heart muscle) experiencing pain in the left shoulder and down the left arm instead of over the heart and the person with appendicitis experiencing pain in the area around the umbilicus instead of directly over the appendix.

Instructional Moves: EEC / CE / CC7E / CE / CEE / CCCC / CCE / CCC / CEE / CCC / CCE / CE / CE / CEE / CCE / EECCE / CECC / CEE / 9C / CCE / CE / CCCEE.
Control Introduction: none.
Learning Activities: Students listened to a lecture on types of pain, causes of pain, reactions to pain, and treating patients who are in pain. This was read from a script with no student participation.

Lewis, 1972

Source: dissertation - microfilm.
Concept: the position of adverbs in Swedish and Norwegian sentences and dependent clauses.
Advance Organizers: Separate advance organizers were prepared for two lessons. The following passages were used for lessons in both Swedish and Norwegian. For the Swedish lessons, the word Swedish replaced Norwegian, and in the second passage, Swedish words replaced the Norwegian words. The Swedish words used were som, att, nar, da, fast, and hvis. Students read each advance organizer before the corresponding lesson.

Lesson One Organizer

In the sentences which you will hear on tape, note the word order: Subject + Verb + Adverb. This is the normal word order in Norwegian sentences. It is different from English in that an English speaker might say: I often drink tea. (Subject + Adverb + Verb is permitted in English).

Lesson Two Organizer

In the dialogue sentences you will hear several examples of dependent clauses. These dependent clauses (also called subordinate clauses) have a word order that is different from the corresponding word order in English. Certain adverbs, such as "into", and others meaning never, always, seldom, already, etc., precede the verb in the dependent clause. Thus within the dependent clause, the word order is: Subject + Adverb + Verb. If there is an auxiliary verb, the adverb precedes it. This is different from English, for example: I wish that he could come often.
subj. Aux Verb Adverb

Hint: Such dependent clauses are frequently introduced by the words som, at, nar, da, fór, skjónt, hvis, and others. They are clauses that cannot stand along as complete sentences, although they contain both subject and verb.

Instructional Moves: CCEC; CEEEEECCEC.
Control Introduction: none.
Learning Activities: Students listened to taped dialogue in Swedish or Norwegian which presented sentences with adverbs in the appropriate positions. They also received printed copies of the dialogue ot memorize and were given a homework assignment in which they were to place adverbs into sentences.

Lucas, 1972; Lucas and Fowler, 1975

Source: Materials were obtained from Lucas, Department of Education, Edenboro State College, Edenboro, PA 16444. Also available on microfilm (Lucas, 1972).
Concept: interrelationships between living things and energy.
Advance Organizer: Students read the following passage.

The sun is the source of all energy. Green plants get energy from the sun. Insects which are many in number eat the green plants around them and they in turn are eaten by insect-eating animals such as frogs and fish. These insect-eaters (frogs and fish) serve as food for flesh-eating animals such as snakes and birds of prey. These flesh-eaters are larger in size but fewer in number.

Instructional Moves: EEEE.
Control Introduction: Students read a passage describing the physical characteristics of clams and snails.
Learning Activities: Students read a passage describing energy changes involved in photosynthesis and the use of food by animals.

Luderer, 1976

Source: ERIC microfiche.
Concepts: cave.
Advance Organizer: The teacher read the following passage.

Caves are exciting and dangerous places. There are many beautiful and awesome sights to examine in caves. Two famous caves are Howe Caverns in New York and Carlsbad Caverns in New Mexico. You will hear a story of how caves were discovered and what you may find inside.

Instructional Moves: CCCEE.
Control Introduction: none.
Learning Activities: Students listened to a tape recording describing a number of characteristics of caves and how a number of caves were discovered.

Malone, 1970

Source: dissertation - microfilm.
Concept: self-regulating control systems.
Advance Organizer: Students read the following passage.

The idea that living organisms have self-regulating control systems is nit new. Although we are just beginning to fully understand these systems, generations of physiologists have described them. Most recently these systems have been described in terms of inanimate feedback systems, much like one finds in a factory.

A system can be defined as a collection of components which are arranged and interconnected in a definite pattern. If such a system contains information about its own regulation, and if one part of the system regulates another part of that system, then we have a control system. An example of such a system is the heating system found in many American homes. A thermostat on the wall regulates the output of the furnace.

In such a heating system, the thermostat is set at a specific temperature level or reference point. The room temperature is fed into this thermostat. This is the input. If the room temperature is lower than the reference point, there is a change in the input. This difference is detected by the thermometer in the thermostat. An electrical signal is then sent to the oil burner, which is ignited. The ignition causes the burning of fuel in the furnace, thus increasing the heat in the system. The heat travels out and through the pipes and is given off to the air. This is the output. In the process, the room temperature is gradually increased. As this occurs, the increase is fed back into the system and is detected by the thermostat's thermometer. When the room temperature reaches the reference point, the electrical signal to the oil burner is discontinued and the system comes to rest.

The function of this system is to maintain the home at a predetermined optimal temperature level. The internal environment of the home is regulated and adjusted in such a way that the temperature is maintained in a steady state. This is done despite changes in the external environment. From this example we can produce a general model of control systems. In this model, the components would be as follows:

1. A reference point which would be the temperature at which the thermostat is set.
2. An input which would be the room temperature.
3. A sensing device or error detector which detects changes in the input. This would be the thermometer.
4. An error signal which informs the controlling component of a change in input. The electrical circuit connecting the thermostat and oil burner would be this component.
5. The controlling component, in this case the oil burner which controls the furnace.
6. The circuit connecting the controlling component and the controlled component would be the controlling signal. In this case it is the circuit between the oil burner and furnace.
7. The controlled component which adjusts the output. In the heating system the furnace is the controlled component.
8. The output which would be the heat produced by the burning of fuel in the furnace.
9. The feedback of the output into the system in this case would be the change in room temperature after the furnace has given off more heat.

If we were to synthesize all these components into one system and represent it in a diagram, the result would be Figure 1. This figure represents a block diagram of the control of a home heating system. Beneath it is another model, Figure 2, which represents the same type of control. The difference you will note is the terms applied to the components. The labels in Figure 2 are the more general terms that can be applied to any like system.

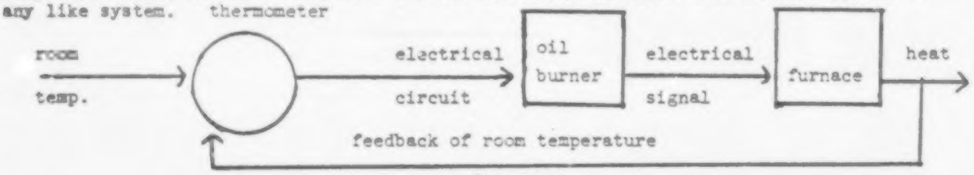


Figure 1

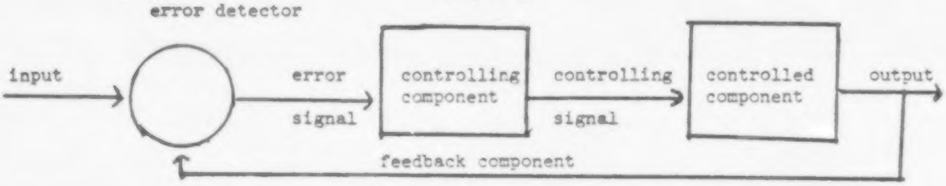


Figure 2

The same basic pattern of control that is illustrated in Figures 1 and 2 exists in many biological systems. We will apply the above model to such a system later. Although the basic pattern of control in many bilogical systems is the same as above, there is one difference. In biological systems the reference point is usually not a set, rigid point, but rather, it fluctuates within a given optimal range. Regulation or control of the internal environment of physiological processes is known as homeostasis, which basically means steady state. A steady state is one in which there exists a balance between the input and output. There is always change, but the changes remain within the limits of tolerance due to control mechanisms.

Since all living organisms inhabit a changing world, it is necessary for the organism to control its reactions and to maintain a steady state. Steady state control is a feature of all living organisms. A good illustrative example of such a physiological control system is the regulation of calcium levels in body fluids such as blood.

It is important for the body to maintain calcium ions in body fluids, within an optimal range, because these ions play a vital role in many physiological processes. The level of calcium ions in the blood is constantly monitored by special cells in the parathyroid glands. These cells, which are able to detect changes in blood calcium levels, are called chemoreceptors. If, for example, the level of blood calcium drops below the optimal range, the result is a steady state error. The chemoreceptors are stimulated and they in turn signal other cells in the parathyroid glands, the chief cells. The chief cells are signaled to release the hormone, parathormone, which they have produced. This hormone travels through the blood stream and causes the release of calcium ions from bones. This action results in an increased level of calcium ions in the blood. The increased blood calcium level is detected by the chemoreceptors in the parathyroids. When the calcium level returns to the optimal range, the parathyroids are no longer stimulated to secrete the hormone and the system comes to rest.

We can see from the examples that the function of a control system is either to cause a mechanism to follow a set reference point, as in the heating system, or, as in the case of blood calcium control, the function is to cause a mechanism to follow a set reference point, as in the heating system, or, as in the case of blood calcium control, the function is to cause a mechanism to maintain itself in an optimal operating range despite the action of extraneous variables. Whether the components are physical or biological, the important characteristic of the control system is that it has an input and output which are constantly compared in order to minimize the steady state error. Again, the important components of the control system are the feedback component, the error detector, the controlling component, and the controlled component, together with their connecting circuits. In order to fully understand how the system works, let us now apply such a model to a biological system, using boook calcium level regulation as our example.

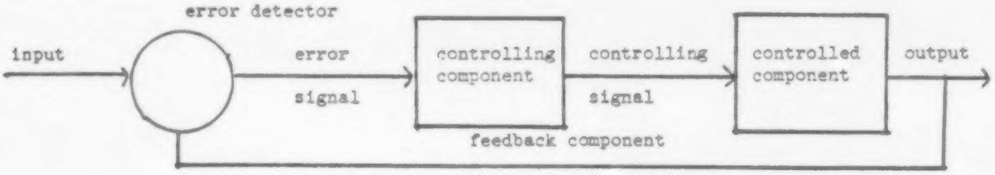


Figure 3.

With Figure 3 as a guide, let us construct a model to represent the control of blood calcium levels based on the information provided on the previous page. We can do this by answering the following questions and following the directions carefully.

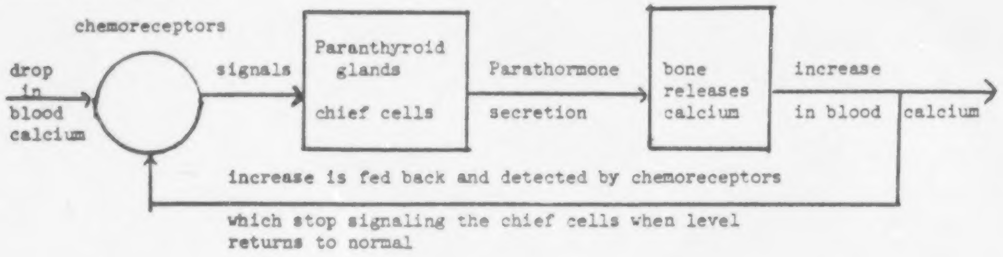
1. What are the various components of a control system? Using Figure 3 as a guide, draw the components and connecting circuits of the control system on the blank page provided.
2. Taking blood calcium regulation as an example, what would be the input into the system? Write the answer in the proper place on the diagram.
3. If there is a change in this input, how does the body detect this change? Fill in the diagram with your answer.
4. Once the change has been detected, what does the error detector do? Fill in the appropriate space on the diagram.
5. What is the controlling component in blood calcium regulation? Fill in the answer on the diagram.
6. What does the controlling component do? Fill in the diagram.
7. What is the controlled component in this system? Fill in the appropriate place on the diagram.
8. How does the operation of the controlling component affect the controlled component? Is there any change in the output?
9. If there is a change in output, what is the result? Fill in the appropriate space in the diagram.

Generally, then, the system works as follows: If the input is changed by a stimulus, the controlling component is activated by a signal from the error detector which detects changes in input. The controlling component in turn signals the controlled component to react and adjust the output. By means of a feedback component, the adjustment is detected by the error detector and when the difference has been corrected, the steady state error is zero and the system comes to rest. This model and mode of operation represents a general outline. In actuality, there may be added details such as a multiple set of components and additional circuits. However, the model established the important concepts of a feedback control system.

Take the folded answer sheet and break the seal. Compare your answers to the questions with the answers on the sheet. If you have made any mistakes, go back and check your work. After you have done this, go back and re-read the introduction once more.

ANSWER SHEET

If you have read the material and answered the questions carefully, the diagram you drew and filled in should look like the one below. If it does not, go back and re-read the information to see where your mistake is. When you have finished, go back and read the introduction once more. Concentrate on mastering the use of the model in addition to learning it.



Instructional Moves: CCCECC / 9CEC / CECCE10CECCC.
Control Introduction: Students read a passage outlining the historical development of the concept, homeostasis. The materials contained questions and answers were provided.
Learning Activities: Students read materials on physiological regulation as illustrated by control of body temperature, food intake, breathing, and blood pressure.

McMeen, 1974

Source: ERIC microfiche.
Concept: Howler monkeys.
Advance Organizer: This consisted of five sentences that were inserted seperately into a programmed instruction booklet. Each sentence was placed immediately before the set of frames to which it referred. Each sentence was preceded by the statement, "This sentence tells what the next few are about."

Young howlers have many forms of play. Howler mothers take very good care of their children. Howlers are usually peaceful, but they do try to frighten their enemies. A tail is very important to a howler monkey. Groups of howlers live in tree tops deep in the forest.

Instructional Moves: 5C.
Control Introduction: none.
Learning Activities: Students worked through a programmed instructional booklet describing a number of characteristics of howler monkeys. Two versions of the booklet were prepared. The small-step-size booklet had 30 frames, and the large-step-size booklet had 5 frames.

Montano Midence, 1974

Source: dissertation - microfilm.
Concept: permutations.
Advance Organizer: Students read the following passage.

This booklet is designed to assist you to develop the fundamental counting principle and permutations as counting techniques.

Extra-sensory perception has been a matter of discussion for many years. There have been many reports in which individuals claim to have learned about thoughts or events through means other than the senses. Based on these reports persons interested in parapsychology have designed experiments to scientifically evaluate the existence of extrasensory perception (ESP).

Most experiments in ESP have the following pattern: two persons are usually involved, one is called the sender (the one who sends the message) and the other one the receiver (the one who guesses the message). The sender will think about symbols that the receiver will guess.

A set of symbols that is widely used in this type of experiments is called Zener* symbols or Zener cards.

There are 5 different symbols: wavy lines, plus sign, star, circle and square.

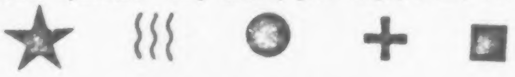


Figure 1.

The following experiments will emphasize primarily the different arrangements or permutations of symbols.

EXPERIMENT No. 1: Two stacks of 5 cards are used with the Zener symbols in each. After being shuffled and cut, the sender will see and think about the card on top of each stack.

One question that arises is "How many different guesses can the receiver make? He will have 5 symbols from which to guess the top card from each stack. For every guess on the first stack he can make 5 different guesses on the second stack.

Suppose that the sender thought about the circle and the square; suppose further that the receiver guesses the circle and the square. Since the pair circle-square is one out of 25 possible different pairs, if guessed then one could ask: is there something else besides the senses that made the receiver choose that particular pair of symbols?

EXPERIMENT No. 2: The sender will think about one of the Zener symbols, and the receiver makes his guess. The sender then thinks of a different symbol and the game goes on until the symbols are exhausted.

In how many different orders may the sender think of the symbols? The question may be reduced to how many different choices there are for the first symbol, and once that symbol is chosen, how many choices are left for the second, and so on until only one symbol is left.

Suppose the receiver chooses as one of the 5 symbols the wavy lines ≋ , then he has 4 choices for his second guess. Let that choice be the square ■ , then there are only 3 choices for the third guess. Suppose that choice is the circle ● , then he has 2 choices for the fourth, and if that one is the star ★ , the last symbol left to be guessed must be the plus sign + .

First he has ≋ ■ ● ★ + to choose from
Second he has ~~≋~~ ■ ● ★ + to choose from
Third he has ~~≋~~ ~~■~~ ● ★ + to choose from
Fourth he has ~~≋~~ ~~■~~ ~~●~~ ★ + to choose from
Fifth he has ~~≋~~ ~~■~~ ~~●~~ ~~★~~ + to choose from

The total number of choices is 120.

EXPERIMENT No. 3: This is a variation of Experiment No. 2, with the difference that the sender will think about three out of the five symbols.

The receiver will have the same number of choices for the first three symbols that he had in Experiment No. 2, that is to say that the receiver will have 5 choices for the first symbol, 4 choices for the second one and 3 choices for the third.

First he has ≋ ■ ● ★ + to choose from.
Second he has ~~≋~~ ■ ● ★ + to choose from.
Third he has ~~≋~~ ~~■~~ ● ★ + to choose from.

The total number of choices is 60.

Knowing the number of different symbols and the number of symbols that the sender must think of, the number of different triples can be figured out.

EXPERIMENT No. 4: The sender, some distance apart from the receiver (say 100 miles) will pick cards from a deck of 10 cards consisting of 2 sets of Zener symbols. In this particular experiment the number of different arrangements that the receiver can guess will be affected by the fact that not all 10 cards are different. If in fact they are different, according the Experiment No. 2 the receiver would have 10 choices for the first symbol, 9 choices for the second, and so on until only one symbol is left. Since there are 2 identical cards for each symbol, some arrangements of the cards will be indistinguishable from each other.

Suppose that one way in which the receiver can guess 10 cards is as follows:

■	●	★	+	≋	≋	+	●	★	■
1	2	3	4	5	6	7	8	9	10

Figure 3

A different arrangement from the one in Figure 3 might be produced by interchanging No. 1 card with No. 3 card

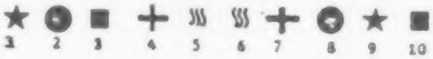


Figure 4

Suppose that from Figure 3 we interchange No. 2 with No. 8.

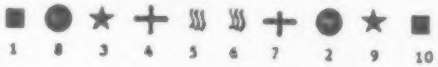


Figure 5

It will be noted that the resulting arrangement or permutation is the same as the original, and thus will not be counted as a different arrangement. Similarly, when other symbols that are alike are interchangeable, they will not produce different permutations of the symbols.

The way of computing the number of different arrangements when the elements are different, or when some of them are alike, belong to the field of counting techniques.

In the booklet that you will receive later, the fundamental counting principle and permutations are developed as counting techniques.

After 60 years of trying to produce evidence that extra-sensory perception exists, no conclusive results are accepted by all the scientists in the field. The general opinion is that more research is needed to know if the mind can only learn indirectly through the senses or if it can learn directly through extra-sensory perception.

Instructional Moves: CEEEC / ECEECCC.
Control Introduction: none.
Learning Activities: Students worked through a programmed instructional booklet on permutations.

Munford, 1971

Source: The materials developed by Ausubel on metals and alloys were used. See Ausubel, 1960.

Murchison, 1975

Source: Since all instruction was given by lecture-demonstration, no written materials are available. The dissertation contains outlines for the control introduction and for the learning session, but not for the advance organizers.
Concept: waves.
Advance Organizers: Two advance organizer lectures were prepared. In the concrete lectures general ideas related to wave motion were presented and demonstrated using slinky toys, strings, and ripple tank. This lecture covered types of waves, wave propogation, reflection, interference and $v=\lambda f$. In the abstract lecture, no concrete materials were used. The chalkboard was used for diagrams. A sine wave was graphically presented and definitions were provided for period, frequency, velocity, wavelength, amplitude and phase. The relationships in $v=\lambda f$ were identified. Students were not allowed to ask questions during the lectures. Students attended only one of the lectures.

Control Introduction: Students attended a lecture on how to take an exam.
Learning Activities: Students attended a lecture-demonstration on sound waves.

Neisworth, 1968

Source: ERIC microfiche.
Concept: sound.
Advance Organizer: Students read the following passage.

SOUND

Do you know what sound is? Sound is anything you can hear. Sound is all around us. When you hear a person talk, or hear a bell ring, or hear music you are hearing a sound.

Do you know what causes sound? Read this lesson to find out what causes sound.

To find out what causes sound you must know about matter. All things are made of matter. You are made of matter. Matter is anything that takes up space. There are three kinds of matter: liquids, solids, and gases.

An example of a liquid is water. Liquids flow easily when poured, (illustration). Coke, Pepsi, and milk are also liquids (illustration). Ice does not flow easily. It cannot be poured. It is a solid. Wood and rocks are solids, (illustration). A solid is hard. It is packed together. It can be picked up easily. Can you think of a gas? Air is a gas. It is not a solid, or a liquid. It is a gas. We cannot see it. It cannot be poured like water and cannot be picked up like ice (illustration). Your mother uses gas for heating and cooking (illustration). Balloons are sometimes blown up with gas (illustration).

All matter is made up of tiny things called molecules. Gases, liquids and solids are made up of molecules. When you squeeze a balloon, you push the gas molecules inside closer together (illustration). You can't see molecules but they are always moving. The molecules of a solid cannot move very fast. Molecules are very close together in anything that is hard or thick. Because these molecules are so close together, they wiggle in the same spot and knock together all the time (illustration). The molecules of a liquid move more quickly and are more spread out than the molecules of a solid (illustration). The molecules of a gas move very fast and are far apart--more far apart than the molecules of a liquid or a solid (illustration).

Sounds are made by anything that moves back and forth and causes molecules to shake or knock together. Sounds move quicker through solids than through air, because the molecules of the solid are closer together and knock together more easily. The ground is thicker than air. Sound moves quicker through the ground than through air. This is why Indians used to put their ears to the ground to hear the sounds made by a buffalo far away. If a buffalo were in the air we couldn't hear sounds that he makes because the molecules in the air are too far apart and don't knock together as easily.

Here is another example. If you held your watch to the end of a long stick, your friend could hear it tick by putting his ear at the other end of the stick. He couldn't hear the watch tick if you took the stick away (illustration).

Fast shaking molecules make high sounds. Slow shaking molecules make low sounds. Sound cannot go through empty space where there are no molecules. Here is an example of how sound travels. (illustration) When a hammer hits a nail, the hit of the hammer makes the air molecules around the nail go out. The molecules spread apart. When they do this, they push against the next molecules in the air and press them closer together. The molecules then go back and hit other molecules farther away. Sound waves are made when a bunch of molecules hit against each other. As a sound wave gets farther away, it gets weaker. Molecules far away from the thing making a sound are not hit as hard. That is why a sound gets weaker as it travels. Your ear catches the sound waves and changes them so that they are carried by your nerves to the brain.

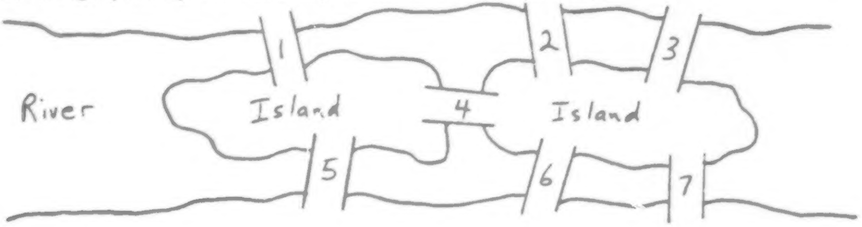
When fast moving sound waves hit something, they jump back. This is called an echo. If you make a sound in an empty room, the sound waves will seem louder because they hit the wall and come back to you. When a lot of people and furniture are in the room, the music is not as loud. This is because the sound wave is stopped by furniture. An empty room makes the sound seem louder (illustration).

Instructional Moves: CCEEEC / CCEECE / CCCECCCCC / CEE.
Control Introduction: Students read a passage describing several sounds in the every day environment and the importance of sound in every day life.
Learning Activities: Students read a passage covering properties of matter, generation of sound, properties of sound, and the physiology of the ear. Several specific examples were included.

Peterson, 1971; Peterson, Thomas, Lovett, and Bright, 1973

Source: ERIC microfiche (Peterson, 1971).
Concept: networks (conditions under which networks can be traced.)
Advance Organizer: Students read the following passage.

In the eighteenth century, in a little German town, Sunday strollers were fond of walking along the banks of the river. The river wandered through the town and was crossed by seven bridges. These bridges ran from each bank of the river to two islands in the river, with one bridge joining the islands, as shown in this drawing.



One day a man asked his friend this question: "Can you take a Sunday walk so that you cross each of our seven bridges and you cross each bridge only once?" The problem interested the neighbor and soon caught the interest of many other people in town. The people tried very hard to answer the question, but no one was able to. Finally, a famous mathematician was able to answer the question.

The mathematician used just lines and dots to represent the above drawing. He let a line stand for each bridge and a point for each island or river bank. He found that you can tell if the question could be answered by looking at how many lines met at each point.

Instructional Moves: EC.
Control Introduction: none.
Learning Activities: Students worked through a self-instructional manual on network tracing. The presentation mode was very similar to programmed instruction.

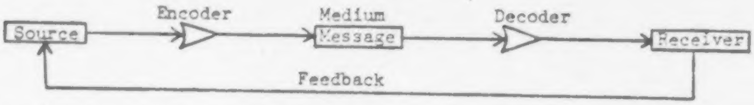
Prescott, 1976

Source: dissertation - microfilm.
Concept: the communication process.
Advance Organizer: Students observed a video tape. Eighteen pictures were shown on the screen as the following text was spoken on the audio track. Some of the pictures represented models of the type shown below within the text of the advance organizer and some were cartoons illustrating the various points.

The Theory of Communication...A Process

Communication is the successful transfer of information from the sender to the receiver. Communication can be verbal or non-verbal. Verbal communication is any form of language-spoken or written. Non-verbal communication non-spoken language. Communication can be continuous or it can be stop/start. This is a communication model.

Communication Model



The major elements of communication are: source of sender, encoder, message or signal, medium, decoder, receiver or destination, and feedback. The source or sender is the first person's brain. The encoder is the vocal mechanism. The message is speech. The medium is air. The decoder is the second person's ear and all of its mechanisms. The receiver is the second persons brain. Last, there is feedback to assure successful transfer of information. There are certain barriers which affect the communication process. They are: noise, the environment and receiver analysis. Noise can be what you can hear-or-noise can be silent. The environment is concerned with the setting in which the communication takes place. A last major consideration is receiver analysis: character of audience.

Instructional Moves: CCCEEC / 7CEC / CCCC.
Control Introduction: none.
Learning Activities: Students listened to a tape recording on the process of communication. They also had a printed transcript of the text and a booklet of visual illustrations.

Price, 1973

Source: Materials were not obtained. A microfilm copy of the dissertation was purchased, but copies of the experimental materials were not included. The materials were taken from the text, Psychology and Effective Behavior, by Coleman, but the local campus libraries do not have a copy of this text.
Concepts: psychotic disorders and neurotic disorders.
Advance Organizers: Separate advance organizers were used for the two concepts (psychotic and neurotic disorders). The students read the paragraph preceding the corresponding sections in the Coleman text. All students read on both topics.

Control Introduction: none.
Learning Activities: Students read the sections on psychotic and neurotic disorders from Chapter VIII of the Coleman Text.

Pucel, 1966

Source: ERIC microfiche. Separate materials were prepared for the topics of metalworking and communication technology.

Metalworking

Concept: The impact of laser technology on metalworking procedures.
Advance Organizer: Students read the following passage.

The laser is a device which appears to have come directly from a Buck Rogers comic strip. Although it is often thought of as a high energy light beam with few practical applications, scientists predict unlimited uses for laser beams in the future. Applications are predicted in many areas of vocational education such as electronics, metallurgy and photography. Since persons training for an occupation, the future uses of the laser are of great concern. A current example of the possible introduction of the laser into an occupational area is its use in metalworking. Lasers emit the most intense radiant energy known to man, and hence, may revolutionize metalprocessing within the next five years. Specialties like microwelding, micromachining and metallurgy are but a few of the fields that will feel the impact. Developments of this type will not only affect occupations concerned with metalworking but also many related occupations.

Metal is a material all of us are familiar with. Since different metals have different properties, terms such as hardness, brittleness, and tensile strength are used to describe them. The given combination of these characteristics must be known before a metal is processed.

Metal processing is done by shaping (cutting), forming (bending), and joining. The most common metals, such as those containing iron, have common characteristics which lend them to processing techniques using heat. For example, cutting steel with a cutting torch or joining steel with a welder. In such metalworking operations heat is usually generated by chemical reactions (burning of gas in a gas torch used in cutting or welding steel) or electrically (cutting with an electric arc or welding with an electric welder). Although chemically and electrically generated heat have been used in the past, metallurgy has produced more durable metals and technology has demanded more accuracy in metal processing; present methods no longer are adequate for these new metals and demands. Consequently, more precise methods using higher intensity heat are being developed. One of these utilizes the laser. The laser produces a very high intensity light beam generated by a chain reaction stimulated by electrical energy. This energy is converted to heat and applied to machining, welding, and spectrum analysis as indicated in the following information.

Instructional Moves: CEEE / CCEEE.
Control Introduction: Students read the first paragraph of the advance organizer.
Learning Activities: Students read a passage describing laser technology and its potential applications in metalworking.

Communication

Concept: The impact of laser technology on long distance communication.
Advance Organizer: Students read the following passage.

The laser is a device which appears to have come directly from a Buck Rogers comic strip. Although it is often thought of as a high energy light beam with few practical applications, scientists predict unlimited uses for laser beams in the future. Applications are predicted in many areas of vocational education such as electronics, metallurgy and photography. Since persons training for an occupation must be aware of possible future developments within that occupation, the future uses of the laser are of great concern. A current example of the possible introduction of the laser into an occupational area is its use in communications. Communications engineers foresee the day when laser beams, rather than wires, will be used to send communications signals. A development of this type will not only affect occupations concerned with communications but also many related occupations.

All of us communicate with others every day. This communication usually takes the form of speech, symbols or signs. In order for people to communicate over long distances commercial devices have been developed. Some of these devices are the telephone, telegraph and radio. Most long range communications devices carry signals from one point to another utilizing electricity. For example, voices are changed into electricity by a telephone, transmitted over wires, micro-waves or some other means of carrying electrical signals, and then reconverted to voices at another place.

Although present techniques have been capable of handling the volume of communications in the past, this volume has been growing rapidly and present devices are nearly at the practical limit of their capacity. This is because present communications devices are limited in the number of voice (electrical) signals that can be transmitted at the same time and the need to amplify the voice signals every few miles. The laser provides a potentially more efficient vehicle for voice signal transmission due to the extreme power of the laser, and the large number of voice signals that can be sent over one laser beam. Communications engineers hope that the laser may overcome many of the limitations of present communications devices. The following information provides details on how this may be done.

Instructional Moves: CE / CCC.
Control Introduction: Students read the first paragraph of the advance organizer.
Learning Activities: Students read a passage describing the transmission of voices over wires and possible applications of laser technology in long distance communication.

Ratzlaff, 1970

Source: dissertation - microfilm. The dissertation contains lesson plans for the classroom instruction used in this study.
Concept: base five mathematics (face value, place value, base, exponentiation).
Advance Organizer: Students attended two classes which were taught from lesson plans developed by Ratzlaff. In the first lesson, the need for the ability to count and calculate was discussed and a counting system using letters in place of numbers was developed. Definitions were provided for face value, place value, base number, and exponent. In the second lesson, these terms were applied to the base ten and base four number systems. Both lessons involved class discussion and individual work on exercises.

Control Introduction: Students attended class instruction on the historical background for number systems with reference to the Roman and Greek systems.
Learning Activities: Students attended class instruction on addition and multiplication in base five. Comparisons were made to the base ten number system.

Rice, Barnes, and Clawson, 1972

This paper reports the results obtained by Clawson (1972).

Rickards, 1975-76

Source: Materials were not obtained. This study was not identified until the analysis reported in the present study was nearly completed and there was not enough time to obtain the materials from the author.
Concepts: the geography, history, government, economy, and social customs of a fictitious African nation.
Advance Organizer: The learning passage consisted of 16 paragraphs grouped in pairs. Superordinate sentences were written to precede each pair of paragraphs. These 8 sentences preceding the paragraph pairs constituted the advance organizers. Each advance organizer sentence subsumed the ideas contained in only one of the paragraph which followed it. An example of an advance organizer sentence is"Southern Mala can best be described as a desert." This was followed by a paragraph which contained facts about amount of rainfall, type of soil, type of fegitation, and temperature. The second paragraph following this sentence described foreign control of the country.

Control Introduction: none.
Learning Activities: Students read a passage describing a fictitious country in Africa.

Romberg and Wilson, 1973

Source: The journal article contains a copy of the advance organizer. A letter requesting a complete set of materials was sent to Romberg, but he did not reply.
Concepts: radioactive decay.
Advance Organizer: Students read the following passage.

As you probably know, the source of energy for the first atomic bomb which so dramatically inaugurated the present nuclear age in 1945 was atomic fission. The controlled fission of elements (or, in more common language, controlled "splitting") that produces bombs was a development of an earlier discovery that certain elements, the building blocks of nature, are unstable and disintegrate. Such elements are called radioactive. As they decompose, they release energy and, at the same time, there is an overall loss of mass. The equivalence between energy and mass is the foundation for much of Einstein's magnificent work. We are moving too fast, however; let us start from the beginning.

Suppose we have a rock containing uranium, which is one of the unstable elements. If we measure the amount of uranium, in grams, in our sample each day, we find that the amount is decreasing. The uranium is disintegrating! If we were able to wait long enough, which means about 2,000 years or more in the case of uranium, about half would have decomposed and turned into lead, an element that is not radioactive. By careful experimentation it has been discovered that the complete reaction proceeds in such a well-organized manner that it can be described mathematically.

Instructional Moves: CCCCECC.
Control Introduction: none.
Learning Activities: Students worked through a self-instructional booklet on the radioactive decay of a fictitious element, quiddium. Data was provided from which students were required to draw a graph. Relative change was also discussed and the general law of radioactive decay was stated.

Ryan, 1968

Source: Materials were not obtained. This study was not identified until the analysis reported in the present study was nearly completed and there was not enough time to obtain materials from the author.
Concepts: geographical features of Japan.
Advance Organizer: Students attended a lecture on the geographical features of California which would help students understand the geography of Japan. Some comparisons between the two areas were made.

Control Introduction: Students attended a lecture on geographical phenomena not related to the geographies of California and Japan.
Learning Activities: Students worked through programmed instructional materials on the geography of Japan.

Ryder, 1970

Source: dissertation - microfilm.
Concept: air pressure.
Advance Organizer: The teacher read the following passage and did the demonstrations identified by the asterisks. Students received a printed copy of the passage and read along with the teacher.

There is air all around us, although it cannot be seen. For the most part, air is a mixture of gases. The air is made up of very very tiny particles called molecules. These molecules are always moving, and there are empty spaces between them. The molecules of air actually have weight and take up space. Since they have weight and take up space, they can exert a push or pressure.* You recall that air is used to blow up a balloon. Within the balloon, the molecules of air push against each other, as well as against the wall of the balloon. If air presses, or pushes much harder one way than another, it could cause something to move, and if anything moves when air pushes against it, we see the results of air doing some kind of work.**

When air is moving very fast along the side of an object, some of its molecules may not hit the side of the object enough times or hard enough to cause a push on it. As a result, the fast-moving air does not press strongly on the surface of the object. In other words, the fast-moving air exerts a very weak push on the sides of the things that it moves over. On the other side of the object, there is a push from the air that is standing still, which is stronger than the weak push of the fast-moving air. The difference in the push of the air on opposite sides of the object could cause the object to move.***

*A transparent box measuring 3½ x 6½ x 11½ inches, and containing ten ping-pong balls, was shaken to demonstrate how moving molecules of air push on the surface of an object.

**A small balloon was blown up to show that air molecules push and are able to do work.

***One end of an 8½ x 11 inch sheet of paper was held with both hands, and air was blown forcefully across the top of it causing the opposite end to lift. This demonstration was performed to show a result of differences in air pressure.

Instructional Moves: CE / CCE / CCE.
Control Introduction: none.
Learning Activities: Students observed four demonstrations on air pressure. The teacher asked two questions on each demonstration and students were allowed to ask questions.

Santiesteban and Koran, 1977

Source: Materials were not obtained. This study was not identified until the analysis reported in the present study was nearly completed and there was not enough time to obtain materials from the authors.
Concept: human population biology.
Advance Organizer: Students read a passage which gave a general overview of the learning passage.

Control Introduction: none.
Learning Activities: Students read an article on human population biology.

Saretsky, 1975

Source: dissertation - received through inter-library loan from Indiana University. The dissertation reported experiments in three subject areas.

Anthropology

Concepts: physical features and customs of a fictitious tribe in Africa.
Advance Organizer: Students read the following passage.

A tribe of tall, lean, light-brown skinned people live in east central Africa. This tribe lives in an area bounded by a mountain, a river, fertile land, and a sandy plain.

The tribe is made up of a complex group system. Membership in a group is determined by ones mother's group membership. Rigid rules are followed by each group.

The tribe's legends and traditions revolve around the Sand Beetle. The Sand Beetle is believed to have been the first living creature. Upon death, tribe members go to help the Sand Beetle rule the world. Four ceremonies are held to celebrate major occasions in tribal life; birth, puberty, marriage and death. The one tribal ritual celebrated is the rising of the full moon.

The tribal council is the highest governing body of the tribe. The council has authority over all actions except for judging decisions and taxes. Judging decisions are made by a special group, while taxes are handled by the national government.

Hunting wild pigs, rabbits and birds is done by the men. Both men and women farm wheat, beets and squash in community plots. Older men and women make pottery, baskets and clothing. Things that are not made by the tribe's men and women are obtained from a traveling trader. The tribe has a system for trading and selling.

Instructional Moves: 16C.
Control Introduction: none.
Learning Activities: Students read a passage describing many characteristics of a fictitious tribe in Africa.

Science

Concept: the relationship between sources of food in the sea and their usefulness to man.
Advance Organizer: Students read the following passage.

Whales grow to be the largest animals on earth. They eat small sea animals that are very nourishing. There are large numbers of these sea animals in the oceans.

Catching these small sea animals is a problem, though. Whales can catch them easily, but they are hard for man to catch in large numbers. Scientists are trying to raise these sea animals and certain kinds of sea plants in tanks and ponds. If this works, sea animals and plants can be used to feed the many starving people in the world.

It is very important that man begins to eat these small animals and plants. When man eats the larger animals that feed on the smaller animals and plants, he is eating very inefficiently and wasting a great deal of the available food. Eating small animals and plants may be the only way to make sure there is enough food for the world's people.

Right now, man catches a small number of the available fish, and increasing the fish-catch is hard to do. Scientists feel that the answer to the problem is in starting "farms" that will raise these small animals in large quantities and help to increase the world's food supply. Someday these sea farms will be fertilized and weeded like regular farms and stocked with better kinds of fish and sea animals.

Instructional Moves: ECCEECC / ECC.
Control Introduction: none.
Learning Activities: Students read a passage on attempts to increase the efficiency of gathering food from the sea.

Literature

Concept: the inevitability of death.
Advance Organizer: Students read the following passage.

Prince Prospero, his country dying from a deadly and horrible disease gathered his friends into his castle. After everyone had arrived, the castle's gates were sealed to keep the disease without.

After several months, a masked ball was held in the seven rooms of the castle. Each room had a colored glass window. The color of each window matched the color of the room's furnishings, except for the window in the seventh room. A torch opposite each room's window provided the only light.

In the seventh room stood a very large clock. Each hour the clock chimed and stopped the ball's gaiety. Nevertheless, the strangely costumed guests laughed and danced until the clock struck the hour. When the clock struck midnight a new guest appeared. The new guest's costume was the strangest of all the costumes. Whispers arose about the costume.

The Prince demanded that his guests unmask this new figure. The guests did not listen to the Prince. The Prince, dagger in hand, rushed after the figure who passed from room to room without being stopped. The figure having entered the seventh room turned toward the Prince. The Prince fell dead. The guests rushed to seize the Prince's killer, but seized only an empty costume.

Thereafter, each guest died. With the last guest's death, the clock stopped, the torches went out. Death held unlimited power over all.

Instructional Moves: EEC.
Control Introduction: none.
Learning Activities: Students read the short story, "Mask of the Red Death", by Edgar Allen Poe.

Scandura and Wells, 1967

Source: Materials were not obtained. Scandura was contacted but materials were not provided. The portion of this report dealing with topology was fropped from the analysis for reasons outlined in Chapter III.
Concepts: mathematical group.
Advance Organizer: Students played a game involving the commands as you were (w), right face (R), left face (L), and about face (A). Students observed the result of executing two commands in succession. For example R * L = W. Various properties of (W,R,L,A) with respect to the binary operation * were discussed with the students. These properties correspond to axioms of mathematical groups, but no mention of groups was made in the discussion.

Control Introduction: Students read bibliographical scketches of some of the mathematicians who developed group theory.
Learning Activities: Students read materials on sets, binary operations, and groups.

Schnell, 1973a; 1973b

Source: Received from author, University of Missouri, St. Louis, 8001 Natural Bridge Road, St. Louis, Missouri 63121.
Concept: the relationship between experience, learning, and neural development.
Advance Organizer: Students read the following passage.

People who teach young children need to be aware that the bodies and minds of those children change as the children get older. Some of the changes take place as though a natural timetable controls them; others seem to depend on out-side stimulation to cause the reactions. At any rate, this process of change seems very important to many teachers because they feel that the children they work with may not have reached a high enough level of development to learn certain tasks. This has caused some educators to adopt a "waiting" policy regarding the teaching of some skills. Others feel that task experience is a basic ingredient in learning that task. It may be that varied early learning experiences are essential to later development.

Instructional Moves: CCCC.
Control Introduction: none.
Learning Activities: Students read a passage describing neural maturation - both spontaneous growth and development dependent on experience. A number of psychological experiments were discussed.

Schulz, 1966

Source: dissertation - microfilm. Materials were prepared for two topics.

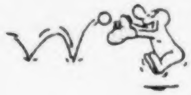
Conservation of Energy

Concept: conservation of energy.
Advance Organizer: Students read the following passage and answered the questions. This material was discussed in class after the students read it.

THE CONSERVATION OF ENERGY

For several weeks you have been studying simple systems. You have observed things that change as well as things that don't change. Now, let's study some sketches that represent still another systems.

System #1

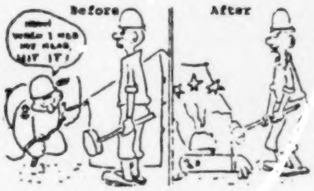


List the objects in the system.

How is the system changing?

In what ways is the system *not* changing?

System #2


Before
After
[illegible] when I nod my head, hit it!

How has the helmet changed?

What caused this change?

Do you think the weight of the helmet changed?

How could you test your guess?

How did you test your guess about the weight of a flash bulb after it was ignited?

Not long ago you guessed what would happen to the weight of an ice cube as it melted. How did you test *that* guess?

Large changes in a system are usually obvious. However, small changes are much more difficult to detect. And when it comes to finding things that do *not* change in a system we almost always have to either count or measure. Objects can be counted. Other properties of objects and systems must be measured.

What would you have to do to test each of the following guesses? (Remember they are only guesses. They may not be correct guesses.)

System #1 (bouncing ball):

a) The ball bounces only half as high on the second bounce as it does on the first bounce.
b) The glove warms slightly when the ball hits.
c) The shape of the ball is always the same.

System #2

d) The higher the sledge hammer was raised, the deeper the dent in the helmet.
e) The dented helmet is warmer.
f) The faster the sledge hammer were swung, the deeper the dent in the helmet.

System #3

Name the objects in the system.

____
____

How is the fuel in the two "racers" changing?

____
____

What changes are taking place?

____
____

What other changes are a result of changes in the fuel?

____
____

All fuels store something that can be passed along through engines to do useful jobs. Jobs like lifting a heavy iron beam to the top of a building. Or moving an automobile along a road. Or launching a rocket. Or heating water for washing dishes.

Scientists use the name ENERGY for this "thing" stored in fuels and passed along to do useful jobs. In fact, you have probably often talked about energy. Yet, as important as energy is, no one knows exactly what it is. About the best we can say is that energy is something supplied by fuels. And we're right back to where we started!

On the other hand, there are a few things we do know about energy.

1) Energy can exist in many different forms.
2) Energy can be measured.
3) --and most important, No matter what form the energy is in and no matter how the energy changes form, the total amount of energy does not change.

Energy simply cannot be destroyed. If we begin with so much energy, we must end with so much energy. Somewhere and in some form we must be able to account for all the energy with which we started.

Scientists say that energy is conserved. Or, they may speak of the Law of the Conservation of Energy. (You may remember that a property of a system that does not change is said to be conserved.) There is no way to explain why this law exists. It just does! It applies to all forms of energy and to all changes of energy. As far as we know, there are no exceptions to this law of nature.

You may not find it too easy to understand what we mean by the conservation of energy. After all, we don't know exactly what energy is. But whatever it is, when we measure it and calculate the total, the total amount always remains the same. The secret, however, is to be sure to figure out the amount of energy in all possible forms each time we add to find the total energy in a system.

Sometimes there are so many different calculations that finding the total isn't easy. Let's see how finding totals might be useful in a different kind of situation.

The Conservation of Twenty Blocks

Imagine there is a little boy who has a set of blocks that are absolutely indestructible--they simply cannot be destroyed. Each block is the same as the other blocks. None of the blocks can even be divided into pieces. And just to keep things straight, let's call our little boy Teddy.

Now Teddy has exactly 20 blocks. In the morning Teddy has 20 blocks, and in the evening Teddy still has 20 blocks. In fact, Teddy's mother carefully counts the blocks each night before Teddy goes to bed.

Then one day when Mother makes her daily check, she counts only 19 blocks. Only 19! Has the number of blocks changed? Or has she simply missed gathering in one of the blocks? She is so sure the blocks cannot be destroyed that she looks everywhere. And finally, there under the rug in the corner of the room is the missing block. Twenty blocks in all!

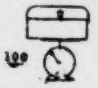
Another day there are only 18 blocks at cleanup time. Mother searches all around the house--with no luck. But then she sees the window is open. Sure enough, there on the ground just under the open window are the missing blocks. Twenty blocks in all!

Still another day Mother is amazed to find there are 21 blocks to put away. This is really hard to understand. Losing blocks, yes! But who ever heard of gaining blocks? Still, Mother is as sure that blocks don't rise out of thin air as she is sure they cannot be destroyed. She tries to remember some of the things that happened during the day, when she suddenly realizes that Teddy had had company. Sure enough, a more careful check shows that the extra block really belongs to the boy across the street. Again, the number of blocks is conserved, twenty blocks in all!

And so it goes. At the end of the day there are always 20 blocks. Until the day, that is, when the count is a mysterious 12. Only 12 blocks. Eight are missing. In searching for the missing blocks, mother is just about to open the toy box when Teddy suddenly screams, "No! No! You cannot open my toy box. I won't let you."

Now, for the first time, Mother cannot tell whether any blocks are missing. But she decides to let Teddy have his way--this time at least.

Several days later, the stray blocks reappear. Once again there are 20 blocks. At a moment when Teddy isn't looking, Mother peeks inside the toy box. It is empty. And now she has an idea. Why not weigh the empty toy box? Then the next time there are missing blocks, even if Teddy won't let anyone peek inside his toy box, it may be possible to tell how many blocks are in the box. So Mother went ahead and weighed the empty box. It weighed 100 ounces. While she was at it, Mother decided to weight some of the blocks. Each block weighed 2 ounces.



This is how Mother's scheme worked the next time there were some missing blocks. This time she was able to gather up 14 blocks. But the toy box (and something inside) weighed 112 ounces. Is it possible the missing blocks were inside?

Are you beginning to get the idea of how calculations are used to check up on the number of blocks? The blocks are conserved, so the total quantity remains the same.

Checking up on the conservation of energy is much the same. You will learn that energy exists in many different forms. In addition energy changes from one form to another. But whatever else may happen, the total amount of energy remains the same. Every time energy changes form or changes into several different forms, the amount of energy in each form must be calculated before the total amount of energy can be checked. Sometimes it is hard to find the energy. Sometimes it is even harder to figure out the amount of energy in a certain form. But whenever the calculations are finished, there is as much energy in the end as there was in the beginning. Repeating, no exceptions have been found to the Law of the Conservation of Energy.

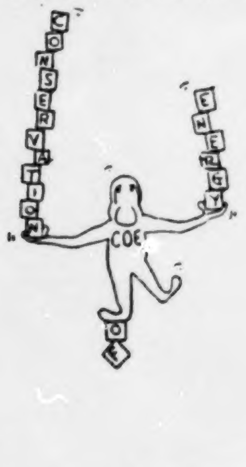
* * *

In the next few weeks, you will study many different forms of energy. You will even learn to measure the amount of energy in a few of its forms. Of course, you will not be working problems as difficult as those scientists must work. But you will be trying to keep track of energy. And in every experiment, in every system, energy must be conserved. If energy is lost in some place or in some form, it must be gained in some other place or in some other form.

Now perhaps it is time to meet Mr. COE, better known as our guide through the next few weeks, Mr. Conservation Of Energy. In fact, you have met him several times already.

Before
▽
Energy stored in the fuel
of a racer.

After
▽
Motion energy.
Heat energy. Sound
energy. Gasoline
still in the tank.



Total Energy Before = Total Energy After

So now it's off to find out more about the forms of energy and the ways it can be "counted up" or measured. First stop--WORK.

Instructional Moves: 17CE.
Control Introduction: none.
Learning Activities: Students worked in a directed discovery setting using prose materials, class discussion, films, and laboratory investigations. This study covered forms of energy, transformation of forms of energy, and conservation of energy.

Cell Metabolism

Concept: cell metabolism.
Advance Organizer: Students read the following passage and discussed it in class.

ENERGY AND CELL METABOLISM - Introduction to Part 2

The Conservation of Energy: No matter what form the energy is in and no matter how the energy changes form, the total amount of energy does not change.

What energy changes do the following sketches suggest?

1)

2)

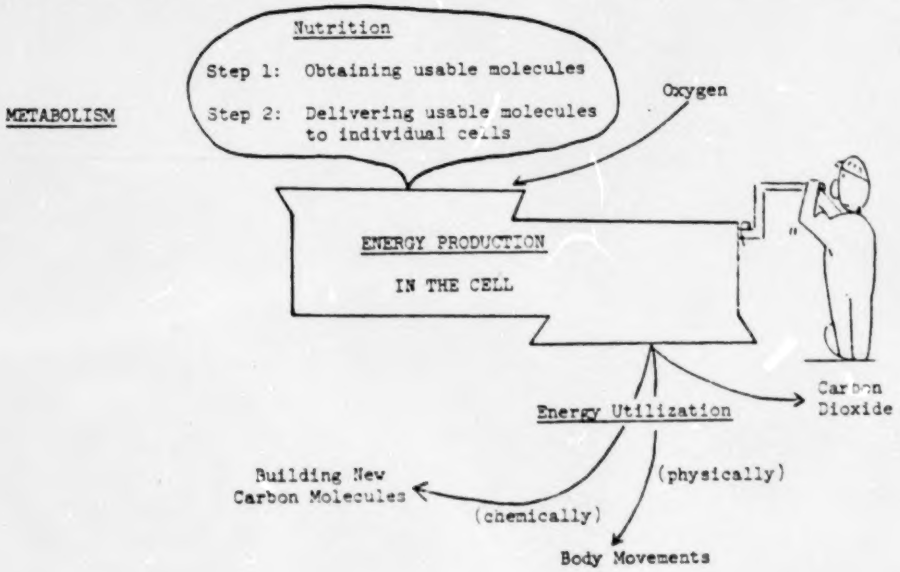
For several weeks you have been observing and studying energy changes in both living and non-living systems. Next, as you complete this year's study of energy, you will be looking much closely at living systems.

Through time lapse photography you have already observed plants at work. Using calorimeters and other simple equipment, you have learned something about how the energy input and output of living things can be measured. But all of your observations have been outside living things. You have been studying the outside story of energy. Now you are going to learn what goes on inside living things. You are going to study the inside story of energy.

You will learn how living things obtain, change, and use energy. How animals must eat food and then break these fuel particles into small molecules their bodies can process. How plants make their own food and what they use as a source of energy. How the energy stored in fuel molecules is changed inside living cells. And how these new forms of energy are then used.

Scientists use the word metabolism to refer to all of the chemical activities that make the living machinery run. Each chemical activity involves one or more energy changes. And each time an energy change occurs--in every system, in every living organism, in every living cell--energy must be conserved.

In the weeks ahead you will never be far from the energy balance sheet. The conservation of energy will be your key to the energy secrets locked inside all living organisms.



Instructional Moves: CCCEE 8C.
Control Introduction: none.
Learning Activities: Students worked in a directed discovery setting using prose materials, class discussion, films, and laboratory investigations on photosynthesis and on respiration in cell metabolism.

Slock, 1974

Source: dissertation - microfilm.
Concept: bacteria - characteristics of bacteria, how bacteria cause disease, and steps to follow in chemical diagnosis of bacterial disease.
Advance Organizer: Students read the following passage.

As a physician, you will be required to solve clinical problems in which pathogenic bacteria are the causative agents. The purpose of this narrative is to provide a "first step" in organizing your thinking and study habits which should enable you to use microbiology in solving clinical problems. The narrative deals with a discussion of the two "groups" of pathogenic bacteria and how each "group" causes disease. These concepts are then incorporated into a step-wise problem-solving approach. A diagram is given to further illustrate these steps. The final paragraph lists those characteristics of bacteria that you will need to know in order to solve clinical problems. These characteristics will be presented in the course lectures and laboratory periods.

Bacteria, when considered as a group, posses certain similarities. Bacteria are unicellular organisms of small size that carry out a complex set of biochemical reactions and are capable of causing a disease response in plant and animal tissue. However, there are some important differences between bacteria. One major difference is cell wall structure. This difference allows bacteria to be divided into two groups, gram-positive bacteria and gram-negative bacteria.

By definition, the first bacterial species to cause symptomatic disease is called the primary invader. If, later in the same disease process, a different bacterial species becomes predominant, it is called a secondary invader.

Most gram-positive bacteria and a few gram-negative bacteria are better equipped to cause tissue damage and to overcome the host's resistance mechanisms because they possess potent invasive factors, such as exotoxins, capsular material, and exoenzymes. Hence, they are usually primary invaders and can infect a healthy host. The success of any invasive bacteria is also related to the member of bacteria that enter the host. The member must be sufficient to overcome the host's defense mechanisms and to reverse the inhabitory effect of the normal flora. In patients with a generalized-type of host alteration, the host's overall resistance to disease is lowered (e.g., diabetes, old age or malnutrition) and thus, fewer numbers of invasive bacteria are needed to establish an infection. Bacteria with high invasiveness can be a part of the normal flora and not cause disease if their relative number is low and the competition exerted by the other bacteria of the normal flora is high.

Most gram-negative bacteria do not have the potent invasive factors needed to overcome a healthy host's resistance mechanisms. Therefore, they are usually secondary invaders, which require the host to be altered in some manner so as to provide a more favorable environment for their survival and multiplication. Since most gram-negative bacteria are usually a part of the normal flora and only cause a disease when a favorable environment is created, this interaction is called opportunism.

The alteration of the host is usually of a specific and localized-type, e.g., rupture of the skin, obstruction ofan organ or duct, a contusion, or an infection by a more invasive bacterial species which has created an area of localized tissue damage. Opportunistic bacteria can then multiply rapidly in such an altered situation causing increased tissue destruction.

A distinction must be made between a generalized-type of host alteration and a specific and localized-type of host alteration. In the generalized-type, e.g., diabetes, old age or malnutrition, the host's overall resistance to disease is lowered and both types of organisms (invasive and opportunistic) must be considered as potential primary invaders. In the localized-type of host alteration, the host's overall resistance to disease is not lowered but rather a specific and local area of the host is altered which allows an opportunist to multiply in the altered area. Again, it is important to understand that this opportunist is usually present as a part of the host's own normal flora.

The following illustrates the ideas discussed above. If an invasive bacterial species enters an area of the body of a healthy host in sufficient numbers, it will cause disease. The introduction of an opportunistic bacterial species under similar circumstances will not produce a disease. If, however, the area is damaged locally, then the opportunist can now infect and produce a disease similar in host response to that seen in the infection by the more invasive bacteria (a diseased organ system will frequently manifest similar symptoms regardless of the bacteria causing the disease). If there is a generalized-type of host alteration, either type of bacteria (the highly invasive one or the opportunistic one) can be the primary invader.

To cause disease, multiplication of bacteria is necessary. Because of their physiology, some bacteria can live and multiply only in certain organ systems. Factors, such as oxygen requirements, and ion-concentration of the organ system, limit the kinds of bacteria that will infect (live and multiply) and cause disease in an organ system.

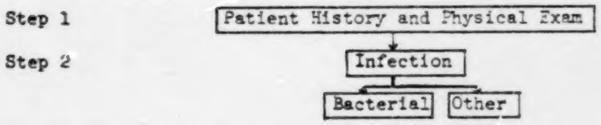
As an approach to solving clinical problems in which bacteria are the causative agents, the concepts discussed above can be incorporated into a step-wise, problem-solving approach.

(1) History and Physical Exam of Patient

It is essential that a careful and accurate history and physical examination are taken. Factors such as age, sex, environment, occupation, and geographical location of the patient play an important role in determining the etiology of a bacterial disease. Other important data include a complete blood count with a differential count, patient's temperature, pressure, pulse rate, etc. Observations made here will influence decisions throughout the remainder of this problem-solving approach.

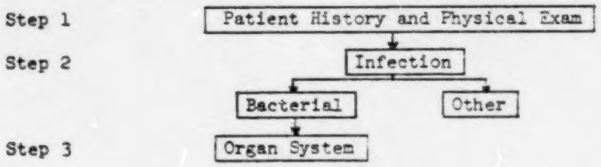
(2) Infection

It must be determined that the patient is actually infected. Some of the characteristics of a bacterial infection are: fever, inflammation, pain and a relative leukocytosis.



(3) Organ System

The site of infection (the organ system) must be identified. Predictable symptoms are associated with infection of specific organ systems. The particular organ system and the physiology of the bacteria limit the kinds of bacteria that can be present.



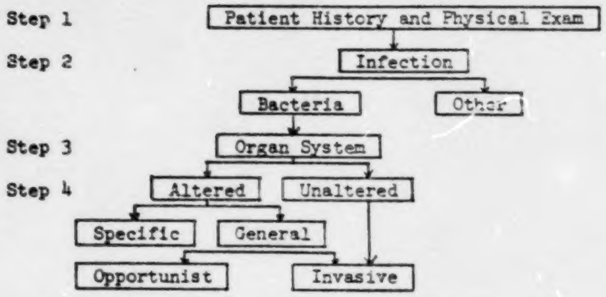
(4) Altered Versus Unaltered Host

When the site of infection is known, it must then be determined if the infected organ system is normal or if it has been altered in some way.

(a) If it is an infection in a healthy, unaltered host, then the more invasive bacteria should be considered.

(b) If the alteration is of a specific type (tissue damage or previous infection), then the opportunistic bacteria should be considered.

(c) If the host alteration is of a generalized-type, then both invasive and opportunistic bacteria must be considered.



(5) Probable Causative Bacteria (Presumptive Diagnosis)

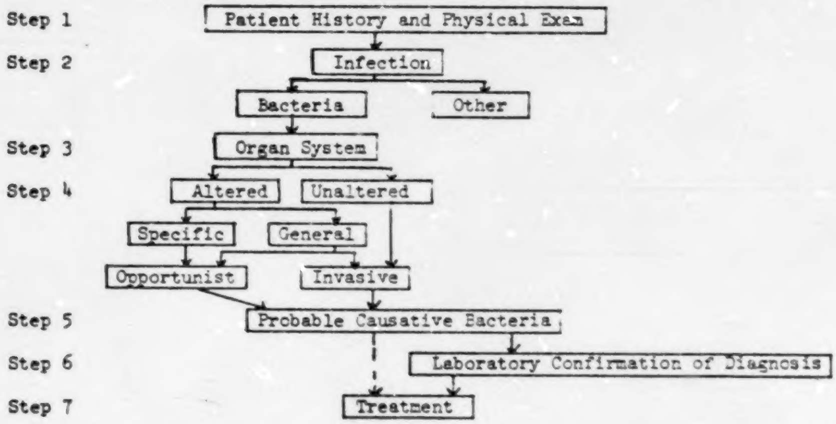
At the conclusion of step 4, the physician should have sufficient information to consider certain bacteria as the probable cause of the disease.

(6) Laboratory Confirmation of Diagnosis

The presumptive diagnosis must be confirmed by appropriate laboratory studies.

(7) Treatment

Treatment involves not only the administration of antibiotics but also correction of the host alteration and prevention of transmission. In certain situations, therapy is started before laboratory confirmation is obtained. The institution of this therapy is based on the presumptive diagnosis. The appropriateness of this therapy must be confirmed by laboratory studies.



It should be clear that specific knowledge of the individual bacteria is important to an accurate diagnosis. Therefore, when studying the individual bacteria in lecture and laboratory, particular attention should be paid to the following characteristics:

(a) is the bacterium gram-positive or gram-negative;
(b) does it possess invasive factors or is it opportunistic in nature;
(c) is it usually involved in primary or secondary invasion;
(d) does it have physiologic limitations, i.e., aerobic or anaerobic;
(e) does it infect all organ systems or just specific organ systems;
(f) does it produce any characteristic symptoms;
(g) how is it identified and differentiated from other bacteria; and
(h) what are the most appropriate methods for prevention and treatment.

Instructional Moves: 5C / CECCECE6C / 37C.
Control Introduction: Students read a passage describing common sense use of antibiotics by medical practitioners.
Learning Activities: Students attended lectures, watched films, and did laboratory work dealing with a large number of specific bacteria.

Smith, 1970

Source: dissertation - microfilm. Separate materials were prepared for two topics.

Electricity

Concept: electricity.
Advance Organizer: Students listened to a tape recording of one of the following paragraphs. Each student heard only one paragraph.

Men have learned to use many things to get their work done. This is not because they are lazy. Men have brains which help them to think of ways to do things that they couldn't do if they couldn't think. Some of the ways they have thought of help them not only to do new things, but also help them work faster and better. One of the most important ways men get work done faster and better is by using electricity. Electricity is energy. Energy is the power to work. There are other kinds of energy - magnets, water, wind, and gasoline, for example. Men can make all of these do work for them. But it is electricity that travels through wires that men count on most to do work.

When we find that our work can be done easier or faster by doing it some other way we usually do it that way. In this way we can be free to think about other problems which might be more important. This also gives us more time to enjoy ourselves. For many years we did not know how to use the power to do work that electricity provided. But when we realized that electricity could be used to do work we thought of many jobs for it to do. We have found other ways beside electricity to get our work done. We have learned to use atomic power, gasoline power, and water power, for example. But electric power is the most common kind of power that we use today.

In our world today there are so many jobs to do. If we could only use our muscles to do all the work we could not begin to get it done. Can you imagine pedaling a car 70 miles an hour uphill? Because we have so much work to do we have learned to use the power of other things to do work. We have learned to use wind to turn windmills to pump water; we have learned that water running down hill will turn water wheels which can help grind our grain. This power to do work is called energy. Today probably the energy that we use most in our everyday life is electrical energy. We use electrical energy or electricity because it can help do so many things.

Man is never satisfied with the way things are. We always want to change things to make them better or easier to do. But if we had to depend only upon our muscles to do work we would not be able to do much work. It would be hard to imagine our life today without cars, lights, heaters, machines and yet without something else to do our work besides muscle power we would not have those things. We have learned to use many things to do work- water, wind, and fire, for example. But the thing that we use most often today to do many kinds of jobs is electricity. Without this way to get work done our lives would be changed so completely that it is difficult to imagine.

Instructional Moves: CCC; CCC; CC; C.
Control Introduction: none.
Learning Activities: Students listened to a tape recording of a passage which listed a large number of examples of how electricity does work for man. A distinction was made between static and current electricity.

Jungle Forests

Concept: adaptation.
Advance Organizer: Students listened to a tape recording of one of the following paragraphs. Each student heard only one paragraph.

It is not an accident that certain plants and animals live where they do. Just as it is not an accident that the animal man is more comfortable some places than others on their planet earth. Plants and animals live where they do because over a long period of time they have changed to fit in with those things that surround them. This is called adaptation. This fact gives us a way to study plants and animals. We can study animals, for example, by learning how they have changed to fit in with their surroundings. These changes have come about so that the animals will be sure to get enough food and protection from their enemies. If plants and animals (including men) did not do this they would all die.

Men cannot live anywhere they want to. When they travel out in space they have to take their home with them much like a turtle carries his shell. Space is not the only place where man can't live; he has a difficult time living in the desert or in dark jungles. He must make changes to live in these places - he builds different houses, he goes out mostly at night, he makes new kinds of machines. This is called adapting. Plants and animals must also learn to change or adapt to stay alive in different places. One of the ways we can learn much about living things is by studying how they adapt to where they live. There are many different ways to group how plants and animals adapt.

Men have always been curious about places that they have never been. Because of this, they figure out ways to get to these places. Just as important, they figure out ways to stay alive when they get to these places. Guns were invented so men could protect themselves. Men learned to use fire to keep warm and scare away animals. If we talk about a living thing changing so that it will be able to stay alive we are talking about adapting. We may adapt or change our thinking as well as what we do. All living things must change to stay alive. This is because our surroundings constantly change. The weather changes. The earth turns. We can learn much about animals by studying how they live in their surroundings.

We are not always able to live where food grows naturally in our yards so that we don't have to do anything but pick it. It is hard to imagine living in a place so perfect that we need no heat nor a way to keep cool. In other words, we must learn to change when it is necessary to stay comfortable and alive. This is called adapting. Plants and animals, too, live in uncomfortable and unfriendly places. They too, must change to stay alive. Animals may change in many ways to stay alive. Their body may change, where they live may change. An important way we can study living things, whether plants or animals, is to study how they adapt or change.

Instructional Moves: CC; ECEEEC; EECC; CC.
Control Introduction: none.
Learning Activities: Students listened to a tape recording of a passage describing how various plants and animals have adapted to live in a jungle.

Tavares, 1976

Source: dissertation - microfilm.
Concepts: observation, assumption, inference, time, space, force, velocity, and acceleration.
Advance Organizers: Advance organizers were prepared for five units of study. Students read each advance organizer before beginning work on the corresponding unit. Because of the length of the materials, only the advance organizer for Unit IV is reproduced here. Brief descriptions of the others are given.

Unit I Organizer

The differences between observations, assumptions, and inferences were discussed with reference to specific examples.

Unit II Organizer

Time was defined and various ways of measuring it were discussed.

Unit III Organizer

The concept of space was discussed and ways of measuring distance, surface area, and volume were described. The concept of displacement was also discussed.

Unit IV Organizer

> "All forces arise from the interactions between different objects. Once upon a time it must have seemed that these interactions were bewilderingly diverse, and one of the most remarkable features in the development of modern science has been the growing realization that only a very few basically distinct kinds of interaction are at work."
>
> A.P. FRENCH

In this unit you are going to deal with two kinds of forces--the gravitational and the magnetic forces. We can now for convenience maintain that forces are of four different types:

a) Gravitational
b) Magnetic
c) Electric
d) Nuclear

Some people would join magnetic and electric forces in one unique type and call it electromagnetic, since analysing more deeply their origin we perceive that both kinds of forces result from the interaction among electric charges.

Our concern is not to define what a force is, but to work operationally with forces.

Everybody has used the word force on different occasions and in most cases have associated it with a push or a pull. The first concept you formed was intimately connected with your muscular effort. Later on the idea of force was extended to include other pushes, such as the ones caused by a magnet. The extension to other kinds of forces outside your body came when you realized that one of the possible effects of a push was the movement of the object to which the force was applied. So, when you saw that a chair could move because you pushed it, you internalized in your mind that, for instance, when an object falls toward the earth, some other force is similarly acting on it. The same happens when a magnet attracts a nail. You recognize also as a result of your experience that sometimes combinations of forces balance themselves in such a way that an object doesn't move and remains stationary.

Your experience also creates for you in the idea that not all pushes are of the same strength and you begin realizing the need to discover a device which can give you a more accurate way of measuring a force. Several alternatives can appear and the problem is to discover a consistent way of describing the force through its effects. We have already associated the movement of a body with one of the effects of a force, but sometimes we can describe the concept better by analyzing the deformation suffered by the object when acted on by a force.

When you hang an object on a spring it stretches a certain amount. When you begin calibrating your spring balance, you will look for a relation among the numbers expressing the amount of deformation and the strength of the forces. In this case the force is the weight of the object and it results from the action of the earth on the object.

Each time you have a force you have interaction among objects.

When a magnet pulls a nail you couldn't have noticed the effect of its action if you didn't have both the magnet and the nail. Both participate in the development of the force even though in certain cases you focus your attention on only one of the objects. The chief points of the discussion so far are:

(1) You measure the effect of a force and not the dorce directly
(2) You need interaction of objects to produce a force.

The next thing that is very important for you to notice is that this interaction depends not only on the distance between objects, but also on another characteristic property of the objects themselves. When you put different pairs of magnets at a same distance they do not probably exert the same force. One of the objectives of this unit is concerned with the identification of this unique characteristic of each of the objects in the interaction.

Suppose you have an object in a certain point around the earth. It is attracted with a pull which you can measure with the spring balance. If you take a second object to the same point and it pulls the spring twice as much, you assume that this second object has a value for this unique property which is twice that of the first object.

This unique property is called by convention the mass of the object and you assume from now on that this property is maintained in the object, regardless of change of location.

With magnets, the same concepts exist, but because the type of forces is different, the constant property of a magnet is called its magnetic strength.

You may now ask yourself why it is necessary to have two objects for the interaction to take place, since you see in the case of the earth and another object that only the last one moves in direction of the earth. In the next unit you will learn that the effect of the forces on two different objects can move them differently, and at that time you will fully understand that really both objects take place in the interaction.

Unit V Organizer

Motion, velocity, and acceleration were discussed.

Instructional Moves: CEEE5C / CCEEECE / 7C; CCCECCCEEECC / 7CEEEC; CCCCECCC; CCC6ECEEEE / CEEEC / CCCEE / CECC / CEECC; CEEE7C / 5CEC / CEC.
Control Introduction: none.
Learning Activities: Students worked through guided inquiry laboratory course work.

Thelen, 1970

Source: dissertation - microfilm.
Concept: water waves.
Advance Organizer: Students read the following passage.

Waves on Water

You have all seen waves rippling across a body of water, whether it was a small pond, or the Pacific Ocean. Where does the energy to move that water come from?

The ultimate source of all energy on this earth is the sun. Let's trace the path of an "energy packet" from its starting point on the sun to see how it can have a connection with the cause of waves.

The sun is an unimaginable inferno - the source of a rremendous out-pouring of all wavelengths of energy. This energy travels through space to us, finally reaching our atmosphere. Here a small part of it is transferred to the upper air molecules primarily in the form of heat energy. But what is "heat"? When we say that an object is "hot", we really mean that, relative to some standard (for example, your skin), the molecules of that object are moving faster. Since "energy of motion" is Kinetic Energy, then we are really talking about the kinetic energy of the molecules ("Temperature" is a way of measuring this kinetic energy on a scale we call a thermometer).

Most of the sun's energy that we have available to us passes right on through the atmosphere and is absorbed by the earth, which therefore heats up, or increases its kinetic energy. This means, then, that the atmosphere is being warmed primarily from underneath, by the warmer earth. The resulting difference in temperature in the atmosphere causes movement of the air which we call wind.

Now that we have followed our energy packet into the area where we exist, let's see what it has to do with waves. The moving air has higher kinetic energy than the surrounding still air. As it moves across the earth, it uses this energy in many ways - blowing sand frains across the desert, driving clouds across the sky, or rippling the waters of a small pond. In all these examples, and countless more, the kinetic energy of the air is transferred mechanically to the objects. If large ripples (waves) are built up on a large pond (the ocean), it is still the same - a transfer of kinetic energy. This kinetic energy is the energy used when the wave finally breaks upon the shore. At this point, the kinetic energy is used mechanically again when it breaks up shoreline materials into smaller and smaller particles.

There is really only one other source of energy for waves - earthquakes. When the earth trembles or shakes, under or near the ocean, some of that energy is transferred to the water. It is still, however, kinetic energy that is being used.

So, you see, it is quite logical to say that the wave that just struck the beach at Cape Cod originated on the sun - or rather, the energy that drove it there did.

Instructional Moves: EEC/ EC.
Control Introduction: none.
Learning Activities: Students observed a film on water waves. The film was discussed in class.

Toth, 1975

Source: dissertation - received from author, Department of Education, Nazareth College of Rochester, 4245 East Avenue, Rochester, New York 14610.
Concept: factors affecting human population growth.
Advance Organizer: Students read the following passage. A graph showing the changes in world population from 1650 to 1960 was included as part of the advance organizer.

MAN AND THE BIOLOGICAL COMMUNITY

Many chapters ago, your study of biology started with a rabbit hiding under a raspberry bush. You learned that any defined groups of individuals - like rabbits - are regarded as a population. When you counted the number of individuals in the population, you expressed this quantity in relation to the space occupied or the population density. You were also told that within any population the rate of change in population density was determined by mortality, natality, immigration rate and emigration rate.

These same ideas also apply to man and human populations. Throughout the course you have realized that man fitted into the biological picture at every point - yet he always seemed to fit in a little differently than did other organisms. You already know that no species can exist independently of all other species. Neither can man live independently of other organisms. The ecological relationships between man and other species are the basis for our concept of the biological community.

In the next several pages you will learn that primitive man was also a member of a biotic community. But gradually, as his technology improved, man's position in the biosphere shifted. An improvement of man's understanding has resulted in improvement in his technology, and improvement in his technology has resulted in improvement of his understanding. The problems of modern man lie as much in the proper application of understanding and technology as they do in the further improvement of either.

Although modern man overrides all natural community boundaries, he still faces many problems. And most of these problems are basically biological. The roots of most major biological problems - from malnutrition to floods, from traffic to smog - lie in the rapidly increasing world density of human population. As in all other populations, this density involves the four determiners mentioned above - natality, mortality, immigration and emigration, of which the last two have (at present) zero values.

The graph on the following page shows the estimated world population of man during the past three centuries. Doesn't this graph bear a striking resemblance to the one drawn back in Investigation 2.1 on the number of house sparrows? As you read on, it will become clearer that solutions to human overpopulation must be through a reduction of natality.

Instructional Moves: 9C.
Control Introduction: Students read a discussion of prehistoric man.
Learning Activities: Students read materials dealing with factors affecting human population growth.

Townsend, 1969

Source: Materials were not obtained. A copy of the dissertation was obtained from Townsend, but the experimental materials were not included.
Concept: straight line kinematics.
Advance Organizer: Students were given a passage to take home and study. The passage illustrated relationships between readings of various dials on an automobile instrument panel.

Control Introduction: Students were given an historical passage to take home and study.
Learning Activities: The instruction covered graphic techniques for analyzing straight line kinematics. Students either attended classroom instruction on this topic or worked through a programmed instructional booklet.

Weisberg, 1970a; 1970b

Source: Materials were not obtained. This study was not identified until the analysis reported in the present study was nearly completed and there was not enough time to obtain the materials from the author.
Concept: characteristics of the ocean floor.
Advance Organizer: Students read a verbal description of the North Atlantic Ocean floor.

Control Introduction: none.
Learning Activities: Students read a detailed description of the features of the floor of the North Atlantic Ocean as an illustration of continental drift.

West and Fensham, 1976

Source: Materials were not obtained. This study was not identified until the analysis reported in the present study was nearly completed and there was not enough time to obtain the materials from the author.
Concept: equilibrium.
Advance Organizer: Students read a passage on chemical equilibrium. Analogies relating unstable chemical reactions to known unstable systems such as surf boards were included. An analogy was also made between the principle of moments and the principle of chemical

equilibrium. Each section of the learning passage was outlined and its contribution to the overall concept was discussed.

Control Introduction: Students read a passage on chemical equilibrium which did not relate to the learning passage.
Learning Activities: Students worked through programmed instructional materials on the principles of equilibrium.

Wong, 1972

Source: Materials were not obtained. A current address for Wong could not be obtained.
Concept: learning theory.
Advance Organizer: Students attended a lecture which presented a philosophical view of man in terms of a continuum from that of a mechanical reactive organism controlled by his environment to that of an organism in control of his environment. The relative positions of some learning theories were identified along this continuum. Students also received a written passage to study for two days for a test on the material covered.

Control Introduction: Students attended a lecture on the teaching of concepts and received a written passage to study for a test.
Learning Activities: Students attended a lecture on S-R and cognitive learning theory. They also received written passages to take home to study.

Young, 1975

Source: The materials developed by Ausubel on metals and alloys were used. See Ausubel, 1960.